

Using AI to make teaching easier & more impactful

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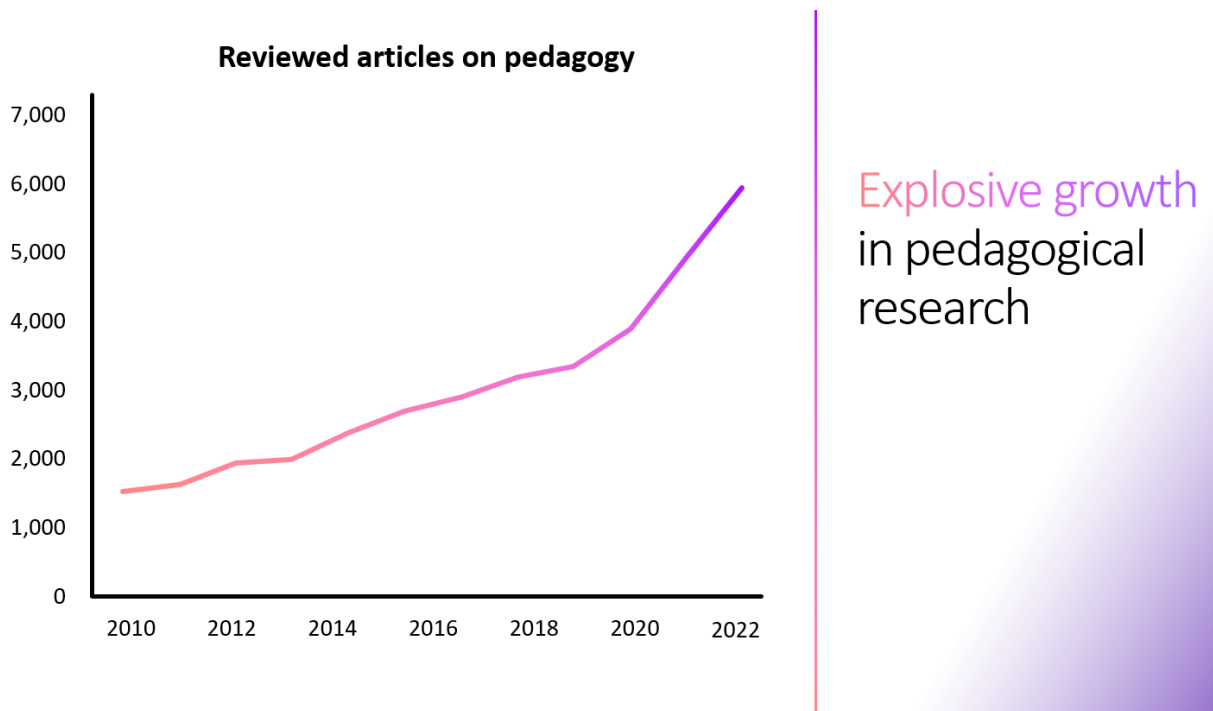
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I don't need to start this post with the usual predictions that AI will transform our classrooms. It is obviously happening. Students are cheating with AI. Students are getting help with AI. I have required AI for all my classes this semester, and I hear more instructors are doing the same. GPT-4 tutors are being launched by large organizations (both Khan Academy and Duolingo currently have them). The world is changing fast.

But one thing that is not changing is the best way for people to learn. We have made large advances in recent years in understanding pedagogy - the science of learning. We know some of the most effective techniques for making sure material sticks and that it can be retrieved and used when needed most.



Pedagogical science is growing fast (Chart from Sarah Toms)

Unfortunately, many of these advanced pedagogical techniques are time-consuming to prepare, and many instructors are often overworked and do not have the resources and time to add them to their teaching repertoire. But AI can help. In the rush to deliver AI benefits directly to students, the role of teachers is often overlooked. AI tutors, as exciting as they are, do not replace the complex role of a teacher in front of a class. But not enough effort seems to be going towards applying AI to help instructors. We have a new paper that tries to remedy that gap, by providing some research-backed approaches to pedagogy, and the AI prompts (for GPT-4, GPT-3.5, and other AIs) to implement them. [You can read the paper here, but I wanted to summarize some of those approaches.](#)

Using AI to Implement Effective Teaching Strategies in Classrooms: Five Strategies, Including Prompts

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March 16, 2023

Abstract: This paper provides guidance for using AI to quickly and easily implement evidence-based teaching strategies that instructors can integrate into their teaching. We discuss five teaching strategies that have proven value but are hard to implement in practice due to time and effort constraints. We show how AI can help instructors create material that supports these strategies and improve student learning. The strategies include providing multiple examples and explanations; uncovering and addressing student misconceptions; frequent low-stakes testing; assessing student learning; and distributed practice. The paper provides guidelines for how AI can support each strategy, and discusses both the promises and perils of this approach, arguing that AI may act as a “force multiplier” for instructors if implemented cautiously and thoughtfully in service of evidence-based teaching practices.

Strategy 1: AI-created examples

Explaining complicated ideas often means giving students lots of examples so they can truly grasp what you mean. When teachers provide multiple examples, it helps students understand abstract concepts in a real-world way, challenges them to think critically, and shows how subtle aspects of ideas can work in different situations. Ultimately, this approach makes it easier for students to apply what they've learned in new areas.

However, coming up with good examples is hard work for teachers, who already have enough on their plates. They have to think about whether examples will capture students' interest, connect to what they're learning, and have the right amount of detail without being too simple or too complex. The balance is key, since examples that are too complicated will just confuse students, while ones that are oversimplified won't actually teach them much.

AI can help teachers generate a ton of diverse examples tailored to what students care about and what they're working on. With AI-generated examples, teachers can make sure they're accessible but also informative. Of course, the teacher remains critical, because they need to vet the ideas and decide how to deploy them. AI just makes the job easier.

You can click this link to get Bing to generate examples:

<https://sl.bing.net/bePdI4o9xf2> (this new feature of sharing links to in-process conversations is a little like sharing programs - paste it into a browser with Bing access to start the prompt)

Or you can use ChatGPT, and paste this prompt in: *I would like you to act as an example generator for students. When confronted with new and complex concepts, adding many and varied examples helps students better understand those concepts. I would like you to ask what concept I would like examples of, and what level of students I am teaching. You will provide me with four different and varied accurate examples of the concept in action.*

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Of course, I'd be happy to help generate examples for your students. Please let me know which concept you'd like examples of and the level of students you are teaching (e.g., elementary, middle school, high school, or college).

Opportunity cost to college students

Here are four different and varied examples of opportunity cost tailored for college students:

1. Choosing a major: A college student is deciding between majoring in economics or computer science. By choosing to major in economics, the opportunity cost is the potential knowledge, skills, and career opportunities they would have gained from majoring in computer science.
2. Studying vs. socializing: A student has a big exam coming up next week but is invited to a party the night before. If the student decides to attend the party, the opportunity cost is the additional study time and potential improvement in their exam performance they could have achieved by staying home and studying.
3. Part-time job vs. internship: A college student has the option to work a part-time job that pays \$15 per hour or take an unpaid internship in their field of interest. If the student chooses the part-time job, the opportunity cost is the valuable work experience and networking opportunities they could have gained from the unpaid internship.
4. Taking a gap year: A high school graduate is considering taking a gap year to travel and explore their interests before attending college. If they decide to take the gap year, the opportunity cost is the potential income and professional development they could have earned by starting college right away and graduating a year earlier.

In the paper, we discuss more about how to assess the quality of examples. You can share the ones you like directly with the class, or use them as part of an in-class exercise. For example, you can ask students to compare and contrast these examples: what different aspects of the concept does each highlight?

Strategy 2: AI-created explanations

Helping students truly understand new ideas is key to teaching them anything. To do this, teachers need to get where their students are coming from, carefully plan how they'll explain things, give students hints to follow


along, and use analogies to bring big concepts down to earth. The goal is for students to be able to explain what they've learned in their own words.

But coming up with lots of ways to explain a single topic can take a ton of time and effort. It can be hard figuring out how to pitch ideas at just the right level, include background info, and adapt for different learning needs. This is where AI can help out.

AI can generate different explanations, walk through ideas step-by-step, and add in more examples. If some students are struggling, AI can provide simpler summaries to get them caught up. Teachers can also use AI to improve their own explanations by making them simpler or adding more examples. But it's important to remember AI-made explanations should be a starting point. Teachers need to check them over before using them with students.

Prompt for Bing: You can use the following link to get Bing to generate explanations: <https://sl.bing.net/koA1v8uUzw4>.

For ChatGPT, try: *You generate clear, accurate examples for students of concepts. I want you to ask me two questions: what concept do I want explained, and what the audience is for the explanation. Provide a clear, multiple paragraph explanation of the concept using specific example and give me five analogies I can use to understand the concept in different ways.*

As a language model, I am here to help you understand various concepts better. To provide you with the most relevant and appropriate explanation, please answer the following two questions: 

1. What concept would you like me to explain?
2. Who is the audience for this explanation?

Once I have this information, I will be able to generate a clear, multiple paragraph explanation of the concept with specific examples. Additionally, I will provide you with five different analogies to help you understand the concept from various perspectives.

Photosynthesis to elementary school kids

Photosynthesis is a process that plants and some other organisms use to turn sunlight, water, and carbon dioxide into food and oxygen. It's like a magical recipe that allows plants to create their own food and grow, while also providing the air we breathe. Let's explore photosynthesis in a more detailed and engaging way for elementary school kids.

Imagine that plants are like little chefs, and they need certain ingredients to cook their food. They need sunlight, water, and carbon dioxide to create something called glucose, which is like the plant's energy source or "food." This process also releases oxygen, which is essential for us and other living beings to survive.

Now, let's talk about the main "kitchen tool" that plants use to make their food: a green pigment called chlorophyll. Chlorophyll is found in the plant's leaves and is what gives them their green color. Chlorophyll's job is to absorb sunlight, which acts like the heat needed to cook the plant's food.

Here are five analogies to help you understand photosynthesis in different ways:

1. Photosynthesis is like baking a cake. The plant needs specific ingredients (sunlight, water, and carbon dioxide) and a kitchen tool (chlorophyll) to make a delicious cake (glucose) that provides energy for the plant and releases oxygen for us.
2. Imagine a solar-powered toy car. The car uses sunlight to move around, just like plants use sunlight to create food and energy through photosynthesis.
3. Photosynthesis is similar to a factory production line. The plant takes in raw materials (water and carbon dioxide) and uses energy from the sun to transform them into a

We describe how to check these results for effectiveness and errors in the paper, but, once you have vetted these examples, you can use them in class, hand them out to students as a study guide to supplement their knowledge, or use them as the basis for exercises.

Strategy 3: Using AI to develop low-stakes tests

Students hate tests, but they are some of the most effective learning tools we have. Contrary to the popular belief that tests only serve to assess knowledge, they actually play a pivotal role in the learning process itself. By incorporating repeated testing and knowledge retrieval, students are better equipped to retain information in the long term.

Low-stakes tests offer active retrieval practice, encouraging students to recall information from memory, which in turn enhances their ability to remember and retrieve information later on. And these tests provide valuable feedback on students' understanding of the material, helping them identify gaps in their knowledge and adjust their learning strategies accordingly. This not only aids in information processing but also prepares students for high-stakes exams.

While low-stakes tests has clear benefits, they can be hard for teachers to put together. Creating good questions, providing scores and feedback, and ensuring questions match what students should know takes significant time and effort. AI can help. They can generate practice questions and provide targeted feedback, allowing instructors to focus on teaching instead of test-making. With AI support, students may learn concepts more deeply through continual practice that sticks with them beyond the lesson.

Here's how to do it in ChatGPT: *You are a quiz creator of highly diagnostic quizzes. You will make good low-stakes tests and diagnostics. You will then ask me two questions. (1) First, what, specifically, should the quiz test. (2) Second, for which audience is the quiz. Once you have my answers you will construct several multiple choice questions to quiz the audience on that topic. The questions should be highly relevant and go beyond just facts. Multiple choice questions should include plausible, competitive alternate responses and should not include an "all of the above option." At the end of the quiz, you will provide an answer key and explain the right answer.*

I am teaching basic cell biology to high school students

Great! Based on your input, I have created a quiz on basic cell biology for high school students. Here are five multiple choice questions:



1. What is the primary function of the cell membrane?
A) Synthesize proteins
B) Produce energy

Answer key and explanations:

1. C) Regulate the passage of substances in and out of the cell
The cell membrane is a selectively permeable barrier that controls the movement of substances in and out of the cell, maintaining the proper internal environment.
2. C) Lysosome
Lysosomes are membrane-bound organelles containing enzymes that break down waste materials and cellular debris, playing a crucial role in maintaining cellular cleanliness.
3. B) Cell wall
The cell wall is a rigid structure found only in plant cells, providing support, protection, and maintaining the cell's shape.
4. B) Protein synthesis and lipid metabolism
The endoplasmic reticulum (ER) is a network of membranes involved in protein synthesis (rough ER) and lipid metabolism (smooth ER).
5. C) Mitochondria
Mitochondria are often referred to as the "powerhouses" of the cell because they produce energy in the form of ATP through cellular respiration.

The expertise of the instructor in avoiding AI errors is key here, as is their judgement in the types of questions to ask. Once that is done, there are many ways to use these quizzes. One option for including tests in a class is

integrating test questions in a discussion or lecture. They give instructors insight into any misconceptions or errors students might have and allow them to make a decision: *Is it time to move on, or do I need to adjust the lesson?*

Low-stakes tests can be given to students in class as a group exercise in which teams report out their responses, followed by a class discussion. They can be assigned as individual classwork or homework or posted in an online discussion forum. Additionally, tests can be distributed in class, and after completing the tests, students can then be given the answer key. They can compare their responses with the correct responses. A follow-up to such an exercise might be a reflection: *What skills do you think you need to work on? How might you improve?*

Strategy 4: Assessing what students know, and what they are confused by

Short check-in exercises are key for helping students and teachers understand the course material. They provide real-time feedback, allowing them to identify gaps in knowledge and areas that need clarifying. While grading assignments shows students their progress, these informal checks for understanding promote active learning and help motivate students by demonstrating that the instructor genuinely values their needs.

One such assessment method, commonly known as the "1-minute paper" or "muddiest point" exercise, promotes active learning and self-reflection. Students are encouraged to summarize their knowledge, pinpoint any uncertainties, and share their perspectives on the material covered. This not only helps identify gaps to be addressed in subsequent classes, but also fosters increased student engagement and motivation by demonstrating that instructors are genuinely responsive to their needs.

To design such an assessment, instructors can choose a specific focus, such as an activity, topic, or class discussion. They can then formulate a question that will reveal both what students have comprehended and what they find perplexing. Potential questions might include: "What was the most important idea or concept discussed in today's class, and why is it significant?" or

"What has been the most challenging concept so far, and what aspects did you struggle to understand?" By prompting students to think more deeply about the course material, these assessments can pave the way for a more enriching and engaging learning experience. Then they can use AI to help summarize the results.

To have the AI help quickly summarize student responses, instructors can create a Google Doc or any shared document and ask students to submit their responses. Then, instructors can submit a set of collective responses to the AI with the following prompt: *I am a teacher who wants to understand what students found most important about my class and what they are confused by. Review these responses and identify common themes and patterns in student responses. Summarize responses and list the 3 key points students found most important about the class and 3 areas of confusion: [Insert material here]*

Based on the student responses, there are several key themes that emerge about what they found important and what they are confused by.

Key Points:

1. BATNA (Best Alternative to a Negotiated Agreement) was the most important concept covered in class. Students found it important to understand the importance of having a backup plan when negotiating with others.
2. Negotiation dance floors was also a critical concept that students found useful to understand. It provides a framework for managing emotions and different communication styles during negotiations.
3. Perspective taking was a crucial idea that students found essential for effective negotiation. Understanding other people's point of view is necessary to build relationships, reach mutually beneficial agreements, and avoid leaving empty-handed.

Areas of Confusion:

1. None of the responses indicate confusion about the BATNA concept.
2. Some students may have found it challenging to understand the nuances of negotiation dance floors and how to use it in practice.
3. There may be some confusion about the practical application of perspective taking and how to effectively incorporate it into their negotiation strategies.

Overall, the responses suggest that students found the class to be helpful in understanding key concepts related to negotiation, but may need further guidance on how to apply them in real-world situations.

You can obviously use this analysis after class to help you see where students stand, or even in-class to see what points you might want to cover (or ask students to cover) further. Students also often love these sorts of exercises because they feel like their feedback is being listened to.

Strategy 5: Distributed practice with AI

Incorporating distributed practice into the learning process is important for helping students build strong and adaptable knowledge. Unlike massed practice, where topics are taught one after the other without much connection, distributed practice means revisiting material several times over



an extended period. This approach helps students form better mental models, remember those half-forgotten facts, and really get a deeper understanding of concepts.

Now, even though it's useful, fitting distributed practice into the mix can be a bit tricky because of how course materials are usually structured and students' preference for massed practice. But AI can help. One way to bring distributed practice into the classroom is by introducing a topic and reviewing it after specific intervals, like a week, a month, and at the end of the semester. Teachers can use AI to whip up brief topic overviews and questions for ongoing assignments or assessments, adjusting the difficulty level as needed.

Linking new ideas to concepts students already know promotes deeper learning, and AI can lend a hand by weaving past topics into lectures or discussions. By asking the AI to find relationships between concepts, teachers can present various connections between ideas, making them clearer for students.

You can use the following link to get Bing to generate distributed practice exercises and tests: <https://sl.bing.net/hnKI78bzvzw> or you can ask ChatGPT: *You are an expert teacher who provides help with the concept of distributed practice. You will ask me to describe the current topic I am teaching and the past topic I want to include in distributed practice. You will also ask me the audience or grade level for the class. Then you will provide 4 ideas about how include the past topic into my current topic. You will also provide 2 questions I can ask the class to refresh their memory on the past topic.*

I am teaching the American revolution. Previously, I taught about the thinkers of the Enlightenment. I am teaching college students in an introductory history class.

Thank you for providing the necessary information. Based on your current topic (the American Revolution) and the past topic (thinkers of the Enlightenment), here are 4 ideas to integrate the past topic into your current topic:  

1. Make connections between Enlightenment ideas and the American Revolution: Discuss how key Enlightenment thinkers like John Locke, Montesquieu, and Rousseau influenced the Founding Fathers' beliefs and the development of the U.S. Constitution. You can also discuss the impact of Thomas Paine's "Common Sense" in sparking the revolution.
2. Compare the political philosophies: Analyze how the American Revolution was inspired by Enlightenment ideals of democracy, individual rights, and the social contract. You can discuss the similarities and differences between the revolutionary leaders' beliefs and those of the Enlightenment thinkers.
3. Role-playing debate: Organize a role-playing debate where students represent different Enlightenment thinkers and American Revolution leaders. Have them debate the merits of independence, the ideal form of government, and how to balance the rights of individuals with the needs of society.
4. Analysis of primary sources: Provide students with excerpts from works by both Enlightenment thinkers and American Revolution leaders. Have them analyze the texts to find connections and influences between the two groups, discussing the ways in which the ideas of the Enlightenment shaped the American Revolution.

Here are 2 questions you can ask your class to refresh their memory on the past topic (thinkers of the Enlightenment):

1. Can you provide a brief overview of the main ideas and contributions of John Locke, Montesquieu, and Rousseau to the Enlightenment, and explain how their ideas influenced the development of modern political systems?
2. How did Thomas Paine's "Common Sense" embody Enlightenment ideals, and what role did it play in shaping public opinion in the American colonies in favor of independence from Britain?

These ideas and questions should help you successfully integrate the past topic of the Enlightenment thinkers into your current topic on the American Revolution, while engaging your college students in a deeper understanding of both subjects.

Once the instructor has some good responses from the AI, distributed practice can be implemented in a number of ways. In terms of timing, scheduling exercises and tests that space out practice across a course and that allow for some forgetting, is optimal. For instance, once students show evidence of understanding about one topic, practice of that topic (in the form

of an assignment or a quiz) may be scheduled once some time has passed; students will need to work hard to pull out that knowledge from memory and that effort will help them access this information next time. You can use the AI output to make sure that happens.

Teaching with AI help

AI is an incredibly exciting tool for teaching. It is widely-available, inexpensive, and fast to experiment with. We hope instructors will try some of the techniques in the paper to get a sense of how AI can make applying complex pedagogical approaches more effective and less burdensome.

And, for those worried about AI, it is worth remembering that, despite decades of hype from VCR classes to Massive Online Courses, technology has not replaced teaching. Instructors, and class interaction, play a vital role in making learning happen. AI allows new forms of learning and pedagogy that can benefit instructors, and their classes. As instructors, we have to experiment to learn the best techniques that work for us, and our students.

