

C1 -- Teachers

The teacher crisis has put our education system on the edge of collapse. White '25

Scott White, 3-7-2025, "Teacher Funding Cut As National Shortage Reaches Breaking Point," Forbes, <https://www.forbes.com/sites/scottwhite/2025/03/07/teacher-funding-cut-as-national-shortage-reaches-breaking-point/>, accessed 3-12-2025 //RP

America's Growing Teacher Crisis The funding cut comes at a particularly critical moment. According to the Learning Policy Institute, the United States faced a shortage of approximately 110,000 teachers in the 2023-2024 school year, with projections indicating the gap could grow to nearly 200,000 by 2026. The problem is most acute in high-poverty schools and rural areas. The shortage is particularly severe in specialized fields such as STEM, special education, and English as a Second Language (ESL). MORE FOR YOU One Of TV's Best Mystery Shows Returns With A 100% Perfect Critic Score FBI Warning—Delete These Texts On Your iPhone, Android Phone BlackRock CEO Issues Serious Warning Amid \$1 Trillion Bitcoin And Crypto Price Sell-Off The shortage has already forced districts across the country to make difficult compromises: More than 40% of schools report having to hire underqualified teachers Nearly 30% have increased class sizes 25% have cut course offerings, particularly in specialized subjects 18% have converted to four-day school weeks in rural areas The Teacher Shortage: A National Emergency CEO: C-suite news, analysis, and advice for top decision makers right to your inbox. Email address Sign Up By signing up, you agree to receive this newsletter, other updates about Forbes and its affiliates' offerings, our Terms of Service (including resolving disputes on an individual basis via arbitration), and you acknowledge our Privacy Statement. Forbes is protected by reCAPTCHA, and the Google Privacy Policy and Terms of Service apply. The teacher shortage is not a new problem, but it has reached alarming levels. Low salaries, high stress, and a lack of respect for the profession have driven many teachers out of the classroom. Meanwhile, enrollment in teacher preparation programs has plummeted by more than 30% over the past decade, according to the Center for American Progress. The COVID-19 pandemic has only worsened the situation, with many teachers retiring early or leaving the profession due to burnout. symbol 00:07 03:12 Read More STEM Teachers: Critical Innovation At Risk Science, technology, engineering, and mathematics (STEM) education faces some of the most critical shortages, as professionals with expertise in these areas often opt for higher-paying jobs in the private sector. According to the American Association for the Advancement of Science, approximately 69% of high schools report difficulty filling physics positions, and 45% struggle with chemistry vacancies. The shortage of STEM teachers has direct economic implications. STEM teacher shortages could result in up to 700,000 fewer students pursuing STEM careers by 2030, potentially creating a \$280 billion economic impact through unfilled technical positions. Special Education: Most Vulnerable Students Affected Special education represents the most severe shortage area, with 98% of school districts reporting difficulty filling these positions. According to Department of Education data, more than 60% of states report special education as their highest-need area. Other Critical Shortage Areas Other significant shortage areas include: Bilingual education and ESL teachers (critical in states with sizeable English-language learner populations). Without enough qualified educators, English language learners—who already face significant academic challenges—risk falling further behind. Career and technical education instructors School counselors and psychologists (where the national ratio is 1:527, far exceeding the recommended 1:250) Math teachers (especially in advanced subjects) Rural educators (with rural districts facing twice the vacancy rates of urban areas). Unequal Impact: How Shortages Affect Different Communities The teacher shortage doesn't affect all communities equally. According to the Economic Policy Institute, high-poverty districts face vacancy rates nearly three times higher than affluent districts. Rural schools struggle with recruitment and retention, while urban districts often face high turnover rates. These areas usually struggle to compete with the higher salaries of suburban schools. The shortage creates a cycle that perpetuates educational inequality: High-need schools face more significant shortages. These schools employ more underqualified teachers. Student achievement suffers. Schools fail to meet performance

metrics. Working conditions deteriorate. More teachers leave. This cycle disproportionately impacts minority and low-income students. A Center for American Progress analysis found that **schools serving predominantly minority populations are four times more likely to employ uncertified teachers than schools with predominantly white student bodies.** Consequences Beyond The Classroom The teacher shortage creates ripple effects throughout society: Widening achievement gaps: **Achievement gaps between affluent and low-income students have widened in states with the most severe shortages. Reduced college readiness: Schools with high teacher vacancy rates report lower college enrollment rates.** Mental health consequences: **The remaining teachers face increased workloads, contributing to burnout and exacerbating the shortage.**

Teachers are overburdened by menial tasks, causing many to quit due to burnout --- AI can solve.

Milberg 24 [Tanya Milberg, MS in public policy and management + manager of education initiatives @ World Economic Forum, 4-xx-2024, Shaping the Future of Learning: The Role of AI in Education 4.0, World Economic Forum, https://www3.weforum.org/docs/WEF_Shaping_the_Future_of_Learning_2024.pdf] BZ

A significant set of work will need to be done by governments and other stakeholders to ensure that a robust set of new talent joins the future teaching workforce, that teachers are adequately remunerated, and that teaching is positioned as a high-growth, high-potential job of the future. **There is an opportunity for AI and other emerging technologies to help address these goals, by supporting those already in the teaching workforce and ensuring that teaching emerges as a “future ready” profession. While technology will never fully replace human teachers, AI and other emerging technologies can immediately address some of this gap. Many teachers already acknowledge the benefits of such support. For instance, in the United Kingdom, 42% of primary and secondary teachers used generative AI to aid with their schoolwork in November 2023, a significant increase from 17% in April 2023.**⁸ Alongside new incentives and structural frameworks aimed at developing, attracting and retaining talent within the education sector, governments, business and civil society can support the integration of AI as a tool for today’s teachers and as an attractive additional skill set for prospective future teachers.

The scarcity of teachers is compounded by the administrative burdens they face in the workforce. A recent survey of teachers in the United States found that while they work an average of 54 hours per week, only 46% of that time is spent teaching. Similarly, when looking across OECD countries, lower secondary school teachers spend an average of about 44% of their working time on teaching and the rest of their time on non-teaching tasks.⁹ **The burden of repetitive administrative tasks is regularly cited by teachers and school leaders as one of the leading aspects affecting the quality of jobs in the education sector.** In the latest OCED Teaching and Learning International Survey, **the main source of stress for teachers in both primary and lower secondary education has been “having too much administrative work to do”, at 47% and 48%, respectively.**¹⁰

Addressing these pain points expressed by teachers and school leaders by automating administrative tasks and augmenting humancentric ones could help free up time that teachers can spend on higher value tasks – such as directly engaging with students, customizing content for maximum impact or developing their own pedagogical skills. Alleviating this burden can improve the attractiveness of the sector, which could in turn help mitigate the global teacher shortage noted in the previous section.

Inefficient assessment processes also hinder the ability of education leaders at the district, national and global levels to make timely and data-driven decisions when it comes to their education strategies and investments. For example, while education systems aim to regularly assess student understanding throughout the school year, comprehensive evaluations that are comparable across schools occur infrequently. Learner performance is typically evaluated sporadically by schools and only annually by Ministries of Education during curriculum review. Meanwhile, cross-country comparisons, such as those conducted through the OECD’s Programme for International Student Assessment (PISA), take place every three years. This lack of frequent data on student learning outcomes and skills gaps prevents education systems from having the agility required to adapt to changing learning and labour-market needs.

Integrating AI technologies into educational assessments offers the potential for educators to gain real-time, data-driven insights into student learning trends, identifying areas of strength and weakness and assessing instructional effectiveness on a large scale. It also helps in evaluating non-standard tests more efficiently, informing instructional decision-making and curriculum development, and enhancing the overall quality of education delivery.

Indeed,

Merod 24 [Anna Merod, education reporter @ K-12 Dive with a degree in journalism from Syracuse University, 8-25-2024, Can AI ease teacher workload as a recruitment, retention strategy?, K-12 Dive, <https://www.k12dive.com/news/AI-teacher-retention-schools-staffed-up/725151/>] BZ

Teachers are swamped.

They're working longer hours compared to other professionals, and their job-related stress often comes from managing student behavior, earning low salaries, and performing administrative work that isn't tied to instruction, according to an educator survey by Rand Corp. released in June.

Furthermore, an April study by Pew Research Center also found that 8 in 10 teachers don't have enough time in the day to complete all of their work. And 81% of those teachers said a major reason for that is they "just have too much work."

As some school districts begin to pilot artificial intelligence tools, however, teachers could see some of their workload burden alleviated.

While not a guarantee, if districts are thoughtful about which AI tools and supports they provide to teachers, the technology has the potential to improve teacher retention by making the job more manageable, said Bree Dusseault, principal and managing director at the Center on Reinventing Public Education. The research and policy analysis center at Arizona State University's Mary Lou Fulton Teachers College focuses on innovative, evidence-based strategies to improve public education.

Dusseault said she has noticed two different ways districts are currently using AI to support teachers. The first is by improving their efficiency in daily tasks like lesson planning and communicating with families. Another is by providing tools such as tutoring or translation services that help teachers offer personalized learning to students, she said.

Anywhere generative AI tools can help teachers focus on their core roles and feel most effective with students, "I think that increases just enjoyment of the job and a sense of satisfaction," Dusseault said.

How one Texas district is leveraging AI

There are many ways AI can help human tasks that typically take three to four hours to be completed in an instant, said Ángel Rivera, superintendent of Texas' Mesquite Independent School District. In the case of teachers, that means they have more time to focus on students, he said.

In his 38,000-student school system, leaders are hoping a platform owned and developed by the district can leverage AI to help teachers better understand students before they even enter the classroom, Rivera said. The name for that platform, AYO, comes from a Yoruban word meaning "great joy."

AYO's components include a social-emotional learning mood check-in for students and a personalized learning tool and lesson planner for teachers, said Cara Jackson, the district's chief technology officer.

The district first launched AYO in 2020 during the COVID-19 pandemic. In 2023, officials decided to relaunch the platform for renewed attention following the pandemic, Rivera and Jackson said. This also provided an opportunity to pilot newer features that use generative AI.

The mood check-in feature allows students to privately report how they're feeling that day, which allows teachers to gauge students' well-being in their classrooms. The tool can also more quickly connect students to counselors during the school day if they report a negative mood, Jackson said.

A newer addition to AYO this year is the lesson planning feature, which is aligned with the state's curriculum standards, Jackson said. Based on AYO's student surveys, teachers can better understand their students' interests, and the AI tool can then suggest concepts for lesson plans based on topics that excite students.

“So AI helps inform, but the teachers — actually the humans — get to decide about the data that’s presented to them,” Jackson said. “Whether it’s about a student or whether it’s about a lesson ... the human still has that option to say, ‘No, you know what? That’s not right.’”

Mesquite ISD is one of 11 school systems nationwide awarded an Innovative School Systems Grant from CRPE and the Walton Family Foundation. The grant program provides funding and resources to allow school leaders “to pilot, refine, and scale new solutions that aim to make student learning more joyful, individualized, and relevant,” according to the program’s website.

According to CRPE’s Dusseault, AYO was developed in part to solve an issue brought forth by counselors and teachers, who expressed concerns about low-student engagement and attendance. So the district worked with those personnel to figure out what kind of data they needed to understand their students and to do their jobs more effectively, she added.

“I think that also helps with recruitment and retention, when you’re using the technology as an aid to solve a really specific problem that teachers are saying, ‘Hey, this is getting in the way of my job,’” Dusseault said.

Independently, AI makes courses more affordable, allowing districts to rebalance budgets to attract teachers with higher salaries and put more money towards student programs.

Post 24 [Rachel Post, 2-1-2024, John Hopkins University educated teacher with a BA from Georgetown in government studies + Policy Fellow @ Leadership for Educational Equity with a focus on emerging technology in education, How Can AI Help Solve Teacher Shortages?, American Association of School Personnel Administrators, <https://www.aaspa.org/news/how-can-ai-help-solve-teacher-shortages>] BZ

When discussing the current state of education with administrators, one theme consistently predominates: the national teacher shortage crisis and its effects on students, teachers, and administrators. At the start of the 2023 school year, there were an estimated 55,000 vacant teaching positions nationwide, an increase of 51% from 2022. An additional 270,000 teachers were working without meeting state qualifications. Coupled with a high teacher turnover rate, peaking at 14% in the 2021-22 school year, districts and administrators across the country are desperate to secure teachers from an ever-diminishing supply.

School districts are reacting with various strategies, from adopting four-day school weeks to offering signing bonuses to reducing teacher licensure requirements. While these measures offer temporary relief, they invariably create deeper problems and they fail to address the root causes of teacher shortages or the long-term well-being of students.

The Rise of AI in Education – Can It Be Used for HR?

The post-COVID era has seen a surge in educational technology and AI, sparking conversations about their potential to revolutionize education. However, this conversation hasn’t yet extended to the HR department. But what if AI-powered technology could provide tangible solutions to the teacher shortage, aid in preparing new educators, and streamline HR operations in schools?

Online Teaching: Filling Immediate Vacancies & Training New Teachers

Due to the shortage of certified in-person teachers, many districts are turning to companies that provide online instruction. COVID compelled teachers and schools to become well practiced in managing online classrooms. Schools are now far more capable than ever of implementing online teaching solutions, and an entire generation of teachers has gained substantial experience in online delivery.

AllCourse, a new edtech company, is using these newfound societal capabilities to help solve teacher shortages. AllCourse is a marketplace linking certified teachers teaching online with school districts looking to hire quickly and painlessly. Akin to other labor marketplaces like Upwork or TaskRabbit, What makes AllCourse unique is the AI it uses to recruit large numbers of highly qualified teachers, which means that AllCourse can offer extremely cost-effective and flexible teacher hiring options. Districts can post jobs for free, and then AllCourse’s AI-powered system then begins to crawl the web, as well as first-degree teacher connections within the AllCourse community, to find teachers who meet the exact qualifications of the job posting. With AllCourse, it’s free and easy to build a large pool of online teachers who are licensed and qualified for all your open roles.

Beyond filling immediate vacancies, online teachers have an unexpected perk – they can help train new teachers. When districts implement online teachers in in-person settings, a classroom facilitator, such as a paraprofessional or substitute, often manages the environment,

monitoring behavior and encouraging engagement. One district in South Carolina decided to use this facilitator role as part of their teacher training program for candidates undergoing certification. These facilitators gain valuable classroom management experience and mentorship from highly-qualified teachers. Furthermore, all AllCourse teachers record their sessions; AllCourse is building a large library of recorded classes that can be used as training tools for new teachers. Online teachers, therefore, can both address the immediate need to fill vacancies and help train the next generation of educators.

AI-Powered Tools: Reshaping Resource Creation to Reduce Teachers' Workload

The potential of AI to change the ways teachers teach is frequently talked about, but what if AI tools could attract teachers by easing their workload? Teacher burnout, resulting from heavy workloads, is a leading cause of high teacher turnover rates, with 44% of K-12 teachers reporting often or always feeling burnout. AI has the potential to reduce teacher burnout by providing tools that allow educators to spend more time on teaching and less time procuring resources. BookBaker, created by AllCourse, is a first-of-its-kind AI content generator that allows teachers to quickly create custom learning materials differentiated for their students and aligned with their curricula. BookBaker allows educators to create any kind of materials – from worksheets all the way up to textbooks – in just a few minutes at 90-99% lower prices than traditional materials. BookBaker is poised to become an essential tool in reducing teacher burnout, as teachers increasingly turn to it to find free materials already created by other teachers or to create their own materials at ultra low cost simply by checking a few boxes. And implementing powerful new AI tools like BookBaker will allow districts to reallocate the billions of dollars spent on textbooks and other learning content to areas such as teacher salaries and student enrichment programs.

BookBaker also helps substitute teachers by enabling them to create standards-aligned, relevant worksheets for students in minutes, ensuring continuous learning even during teacher vacancies and situations where there are no sub plans.

Overall, AI reduces workload AND boosts outcomes --- peer reviewed studies agree.

Mafi 25 [Dr. Sam Mafi, MA in information technology + lecturer @ the Faculty of Humanities and Social Sciences Nakhon Ratchasima Rajabhat University, 1-xx-25, EXPLORING THE FEASIBILITY OF AI IN ADDRESSING LECTURER SHORTAGES AND COMPETENCE ISSUES IN THAILAND'S EDUCATION SYSTEM, International Journal of Worldwide Engineering Research, pg. 5-6, <https://www.ijwer.com/paperdetail.php?paperId=e95d54702c13b9e7985586861eb9349e&title=Exploring+the+Feasibility+of+AI+in+Addressing+Lecturer+Shortages+and+Competence+Issues+in+Thailand%26%23039%3Bs+Education+System&authpr=Dr.+Sam+Mafi>] BZ **don't ask why the link is so long, I don't know**

4.2. Pilot Testing of the Adaptive Educational AI Platform (AEAP)

The AEAP system was tested across three types of schools: urban, rural, and underserved areas. The outcomes

demonstrated the following:

1. AI as a Tool for Qualified Lecturers:

- o Enhanced Efficiency: Educators reported a 40% reduction in time spent on administrative tasks.
- o Improved Teaching: 87% of teachers found the AI recommendations for differentiated instruction effective.

2. AI as a Replacement for Unqualified Lecturers:

- o Performance Comparison:

- Students taught by AI instructors scored 15% higher in language assessments compared to those under unqualified human educators.

- o Engagement Metrics:

- AI-powered interactive modules achieved an 80% engagement rate, particularly effective in gamified content delivery.

- 3. Student-Centered Outcomes:

- o Personalized learning paths resulted in a 22% improvement in student comprehension and retention rates.

- o Rural schools reported a 30% increase in attendance due to the engaging nature of AI modules.

Failure to adapt has dire consequences.

Perna 22 [Mark C. Perna, expert author on education and contributor @ Forbes, 1-4-2022, Why Education Is About To Reach A Crisis Of Epic Proportions, Forbes, <https://www.forbes.com/sites/markcperna/2022/01/04/why-education-is-about-to-reach-a-crisis-of-epic-proportions/>] BZ

We're at a major tipping point in education. According to a recent survey, 48% of teachers admitted that they had considered quitting within the last 30 days. Of that number, 34% said they were thinking about leaving the profession entirely.

Understaffing has plagued schools for years, but it's now reaching epic proportions. At a conference last month, I sat around the table with four superintendents from various parts of the country and asked them, "What percent of teachers quitting would create a cataclysmic drop in your organization's ability to educate young people?" The answers were all shockingly low—with one superintendent answering, "One. One teacher quitting would hurt us in a big way."

Teachers and administrators alike are stressed, overworked and at the end of their rope. After the tremendous pressures of the past two years, they have nothing more to give. They are already giving everything—time, energy, mental wellbeing, and heart. They're beyond tired. They're exhausted. Conditions in the education field have always trended toward demanding, but today they're a recipe for burnout—which teachers experience almost twice as much as other government employees.

At the same time, teachers are very hard to replace. The specialization and requirements inherent to the field of education make it extremely difficult to expand the talent pool, as other fields are often able to do.

It's not sustainable. And as a nation, we're about to feel it.

The vicious cycle

In order to reach and teach students effectively, teachers must forge a human connection with them. Today's younger generation simply will not move forward in their education and career journey without that connection. This is a non-negotiable; it's just who they are.

The vast majority of teachers truly want to forge that meaningful connection with students. In fact, for many it was the driving force behind their decision to enter the profession. But, understaffed and overworked as they are, many simply have no time to show students that they see, hear, and care about them. Survival mode—where many teachers have lived for the past two years—doesn't allow much room for relationship building.

This creates a vicious cycle. Students aren't performing, so more burdens are placed on teachers to help students hit the mark, thus decreasing teachers' time and bandwidth to forge a human connection with students that is the basis for all learning. Teachers' legs are cut out from under them, yet they're still expected to carry their students across the finish line. It's a gridlock.

The fallout

What's the fallout of all this burnout and lack of connection? We'll see significant drops in three vital areas:

A drop in young people entering the profession. Teachers and students spend hours every day together—and unfortunately, stress isn't easy to hide. Even teachers that don't actually mention their stress to the class manifest it in a thousand small ways that young people can observe.

The elevated and prolonged levels of teacher stress are warning the next generation not to become teachers. Who wants that kind of life, for that kind of money? Obviously, fewer people entering education will only exacerbate the teacher and substitute shortage for the long term.

The skills gap is going to hit the education field hard. There just won't be enough teachers to go around.

A drop in education quality. As current educators flee the profession and the next generation avoids entering it, we may see class sizes skyrocket—further straining the teachers that remain. Without a healthy student-teacher ratio, the quality of instruction, the individual time spent with each student, and any vestige of a human connection will inevitably drop.

The quality of education will also drop if states, desperate to staff their schools, lower the bar for teacher requirements. Such a move could potentially bring into the classroom "teachers" or substitutes who lack the necessary training and skills to teach effectively. A lower-quality educational experience will hurt not just the students, but soon the workforce and economy in significant ways.

A drop in graduation rates. How long before students, unengaged in school and with no human connection there, realize that there are ways they can succeed without that diploma? The gig economy has a place for them. There's always bitcoin. And no one will question their graduation status if they start their own business.

Skills, rather than diplomas and degrees, are coming to the forefront in the hiring process. Amid our record talent shortage, employers are frantic for workers and are trying to entice them by any and all means: higher wages, sign-on bonuses, flexible work arrangements and more. How long before they relax their requirements to hire workers with the ability to do the job, even if they don't have a high school diploma?

This highly entrepreneurial generation is savvy enough to realize they can start making a living now—and worry about getting their GED later. If they don't feel that human connection at school, they're checking out, and not just mentally. They're not going to stay on a sinking ship.

That would be disastrous.

Relx 20 [Sustainable Development Goals - Resource Centre; 2-7-2020, "What Is the Connection Between Education and Poverty?", <https://sdgresources.relx.com/features/what-connection-between-education-and-poverty>] sumzom

Education is a Key Factor in Poverty Reduction

Education is considered to be one of the most effective ways to combat poverty. It has been proven that education has the power to transform people's lives and create opportunities for personal and economic growth. In fact, research shows that every year of education can increase an individual's income by up to 10%. Education can also provide people with the skills and knowledge they need to secure employment and become financially independent.

Lack of Education Leads to Poverty

On the other hand, a lack of education can perpetuate poverty and hinder economic growth. When individuals do not have access to education, they may not acquire the necessary skills and knowledge to find employment or create economic opportunities for themselves. This can lead to a cycle of poverty, where individuals and families struggle to make ends meet and are unable to improve their standard of living.

C2 -- Innovation

College campuses are the bedrock of American Innovation. The Bush Institute in 2020 writes

Bush Institute, 6-17-2020, "The Innovation Impact of U.S. Universities," George W. Bush Presidential Center, <https://www.bushcenter.org/publications/the-innovation-impact-of-u-s-universities>, accessed 3-13-2025 //RP

Connecting innovation activities to economic growth and prosperity America's long-term economic growth demands a stepped-up commitment to promoting the innovation impact of the nation's top-tier universities and other research institutions. For research institutions themselves, this commitment means prioritizing research, empowering great researchers, building efficient and outcomes-focused technology transfer operations, instilling cultures of innovation and entrepreneurship, and engaging with surrounding business and innovation communities. For America as a whole, it means funding more research resources and paying more attention to the worldwide competition for human talent, including high-skilled immigrants. American universities play a pivotal role in fueling innovation, which in turn drives economic growth and raises living standards in the United States. U.S. universities spend approximately \$75 billion per year on research, amounting to 13 percent of America's total spending on research and development (R&D). Most of this spending funds research activities in science, technology, engineering, and mathematics (STEM) fields. Universities conduct a majority of the country's basic research, while the private sector largely focuses on product development, which is often reliant on discoveries from basic research. The overall volume and quality of R&D activity in turn drive the pace of technological progress in the economy as a whole. The COVID-19 crisis has dramatically underscored the importance of great research institutions to America's well-being and economic future. Major research institutions are at the center of efforts to understand and combat the novel coronavirus, focusing new research programs on the emergency at a scale and pace reminiscent of their national defense mobilization during WWII. The economic aftershocks of the COVID-19 crisis threaten the financial models that underpin America's world-leading universities, raising urgent questions for policy makers. But institutions that build competitive research operations around life science, biotechnology, and other vital STEM fields are likely to be successful in overcoming growing challenges to traditional ways of doing business in higher education. This report sets forth a new set of rankings of U.S. research universities and research institutions for innovation impact. We rank institutions for overall innovation output and separately for productivity in converting research inputs measured in terms of research spending to output. Our aim in publishing rankings is to highlight high-performing institutions — particularly stand-out performers in innovation impact productivity — so that other institutions, as well as policy makers and other leaders, can learn from their example. We also look closely at why some universities are exceptionally productive in generating innovation impact through their research activities.

Generative AI is key to research.

Brown 24 [Monika; Freelancer in data visualization; 3-21-2024; "How Generative AI Can Improve Scientific Experiments", University of Chicago Booth School of Business; <https://www.chicagobooth.edu/review/how-generative-ai-can-improve-scientific-experiments>; DOA: 2-12-2025] sumzom

Artificial Intelligence is rapidly changing jobs and industries, causing no small amount of consternation as it does. But on the bright side, it has the potential to greatly aid economists by streamlining experiments' design and implementation and leveraging behavioral insights, suggests research by University of California at Santa Barbara's Gary Charness, Chicago Booth principal researcher Brian Jabarian, and University of Chicago's John A. List.

Recent advances in generative AI, mainly through large language models, have sparked considerable interest. For one example, after OpenAI launched LLM-based ChatGPT, its valuation exploded, competitors rushed to keep up, and Microsoft kicked in \$10 billion. Across the world, people are scrambling to understand how LLMs will transform jobs, the labor market, and various companies and sectors.

Science, as many researchers have noted, is not immune. And as Charness, Jabarian, and List explain, LLMs can help revolutionize how it is practiced. Addressing economists in particular, they write that LLMs could be harnessed to scale up experiments, make findings more accessible, and foster a culture of critical thinking of evidence-based analysis. LLMs could be used to improve nearly every step of an experiment, they explain—and they propose specific approaches for doing so. "All these offered directions require experimental benchmarking before becoming established scientific policies," qualifies Jabarian.

They group their recommendations into three categories: the design phase of an experiment, the implementation phase, and the analysis phase. Design involves crafting and coding an experiment, and here, they write, LLMs offer a groundbreaking approach to literature review, hypothesis generation, and experimental setup. LLMs could be used to analyze extensive data sets, identify gaps in knowledge, and help generate research ideas. AI could speed up the brainstorming phase while ensuring that research hypotheses are well-grounded.

Once a research question or hypothesis is in hand, LLMs could recommend a suitable experimental design, be it an economic game, market simulation, or something else. Drawing on knowledge learned from their training data, they could guide whether an experiment should be conducted in the lab or the field (or both). AI could help determine the optimal sample size for study and calculate the minimum number of participants needed to achieve statistically significant results—balancing the need for robustness with practical considerations such as cost and time limitations.

In the implementation phase of an experiment, the real-time capabilities of LLMs become particularly useful, the researchers write. By functioning as interactive chatbots, LLMs could provide immediate support to participants, clarify instructions, answer questions, and ensure compliance with the experimental protocol. They would produce a better experience for participants while also safeguarding the integrity of and monitoring an experiment. If a participant were to misunderstand instructions, become less engaged, or even cheat, LLMs could detect that and take steps to address it—all while reducing the workload for human researchers and minimizing the potential for errors.

And LLMs would significantly expand the scope and depth of data interpretation in the analysis phase, according to the research. Through state-of-the-art natural language processing techniques, they could analyze qualitative data such as participant feedback or chat logs, and extract insights that traditional statistical methods might miss. They could organize and clean data efficiently, which not only speeds up the pre-analysis process but allows researchers to focus on interpreting results and drawing conclusions. And LLMs could be used to conduct statistical tests, generate visualizations, and identify patterns or correlations.

Ultimately, generative AI opens up new avenues for exploration and discovery, the researchers write. But while outlining these and other advantages, Charness, Jabarian, and List acknowledge risks to using LLMs in experiments, "including concerns about intellectual property (IP), digital privacy issues, user deception, scientific fraud by fabricating data or strategies to hide data manipulation, hallucinations," and more. Reliance on LLMs could result in less creative research questions, they posit, as standardization in prompts and other processes "could, in principle, create research drones" and "lead to lost opportunities for new wisdom, thought, hypotheses, and scholarship needed in the face of every new societal challenge."

But the advantages of using LLMs, they conclude, outweigh these drawbacks—and the scientific community should adopt a structured approach that amplifies the benefits and reduces the risks. Creating such a framework would hopefully, they write, “foster a culture of policy and industry experimentation at scale.”

AI works alongside researchers to minimize risks and maximize gains.

Li 23 [Zhicheng; Programme of Applied Psychology, School of Humanities and Social Science, The Chinese University of Hong Kong, Shenzhen, Guangdong 518172, People's Republic of China; August 2023; "Why and how to embrace AI such as ChatGPT in your academic life," PubMed Central (PMC); <https://pmc.ncbi.nlm.nih.gov/articles/PMC10445029/> DOA: 2-12-2025] sumzom + mac

Ever-growing scientific advances and data present a significant challenge: a ‘burden’ of knowledge that leaves researchers struggling to keep up with the expanding scientific literature. By contrast, the explosion of knowledge and data is fuelling machine intelligence. The rapid progress in generative AI (see box 1 for a non-technical primer) in the past few years, especially in large language models (LLMs), is a game-changer [1,2]. It is well suited to alleviate the knowledge ‘burden’ and has the potential to revolutionize scientific research. To facilitate the adoption of this new technique and foster discussions and empirical research on the changing landscape of scientific research in the era of generative AI, here I provide a how-to guide for using LLMs in academic settings and offer new perspectives on their implications as informed by epistemology and philosophy of science.

Box 1. Generative AI, large language models and ChatGPT/Bard.

Generative AI trains machine learning (ML) models on a dataset of examples to generate new examples similar to those in the training set, including text, images and music. This generative ability distinguishes it from predictive AI, which trains models to predict outcomes on new, unseen data, such as in image classification and speech recognition. Although generative AI dates back to the 1950s, the breakthrough came only recently, thanks to the availability of massive amounts of data and the development of deep learning algorithms (‘deep’ refers to the use of multiple layers in artificial neural networks). These algorithms afford the creation of large language models (LLMs) to be trained on vast amounts of diverse text data.

Many state-of-the-art LLMs use a type of deep learning algorithm called transformers as their backbone.

Introduced in 2017, the transformer architecture is a type of deep neural network architecture that uses self-attention mechanisms to better process sequential data such as text. Self-attention allows the network to calculate the attention weights between every pair of input elements, effectively allowing the network to weigh the importance of each input element with respect to all other elements. Thus, it allows the network to dynamically focus on different parts of the input sequence and capture long-range dependencies in the data. This mechanism enables it to understand and interpret language in a way that is similar to humans.

One of the most powerful LLMs is Generative Pre-trained Transformer 3 (GPT-3), introduced in 2020 by OpenAI in San Francisco, California. GPT-3 has been trained on a massive amount of text data, allowing it to generate human-like text and excel at challenging natural language processing (NLP) tasks. Recently in November 2022, a derivative of GPT-3 called ChatGPT was launched. It has fine-tuned GPT-3 using reinforcement learning from human feedback (RLHF) in a smaller dataset specifically for conversational tasks, making it both conversational and computationally efficient. GPT-3 was updated to GPT-4 and released to the public on 14 March 2023. Another powerful transformer-based LLM is PaLM (Pathways Language Model), developed by Google AI. PaLM has been finetuned to support the chatbot, Bard.

To understand and harness the capacity and potential of generative AI, I will illustrate its capabilities using the popular chatbot ChatGPT. ChatGPT reached 100 million users within just two months of its launch on 30 November 2022. A similar chatbot is Bard, which was launched by Google on 21 March 2023 (see table 1 for a list of other tools). In what follows, I will first identify and elaborate on three features of LLMs, as exemplified by ChatGPT, that make them unprecedentedly apt to augment, if not transform, research life: intelligent, versatile and collaborative. I do so by incorporating specific, practical examples commonly encountered in biomedical and behavioural research. As LLMs are rapidly evolving, I also offer a living resource online, complete with documents that provide tips on crafting effective prompts, examples of usage and relevant links (<https://osf.io/8vpwu/>).

<<TABLE 1 OMITTED>>

Next, I will critically discuss the limitations of LLMs and, importantly, their ethical and responsible use, as well as implications for equality and education—a debate still in flux. Specifically, I argue that while guidelines for using AI such as ChatGPT in

academic research are urgently needed, policing its usage in terms of plagiarism or AI-content detection is likely of limited use. More fundamentally, if AI-created content is deemed valuable based on peer review, there is no reason to reject such content—the identity of the originator of that content is irrelevant from an epistemic point of view. As long as the use of AI is transparently disclosed, there is no need to limit the scope or nature of the assistance it can offer. If, however, the content produced by AI is not original or valuable but still passes peer review, then the problem lies not with AI but with structural issues in the peer review system—AI merely exposes its weaknesses and calls for concerted efforts to improve it. Concerning implications for equality, I contend that generative AI may foster equality for some but exacerbate disparities for others, based on considerations at the individual, group, and national levels. With regard to education, I advocate for the importance of engaging with LLMs and developing critical thinking and analytical skills in students. Given the early nature of generative AI in scientific research, empirical work is scarce, and the views expressed here aim to stimulate further efforts in addressing these important issues.

2. Three features of generative AI that make it valuable for researchers

2.1. Intelligent

AI is created to perform tasks that typically require human intelligence, including understanding language. According to multiple benchmarks—ranging from Advanced Placement (AP) exams to the Uniform Bar Exam—it is increasingly capable of performing language tasks at a level that matches or surpasses average human performance [3]. Indeed, LLMs such as ChatGPT go beyond generating language to show some form of behaviours that seem to resemble general ‘intelligence’, including problem-solving and reasoning [4].

Formal tests corroborate these observations. For example, in medical question answering, ChatGPT not only achieved accuracy higher than the 60% threshold on the National Board of Medical Examiners (NBME) Free Step 1 dataset—comparable to a third-year medical student—but was able to provide reasoning and informational context [5]. As another example, consider its ability to generate medical-research abstracts based on just the title and journal of the original papers. Not only was there no plagiarism detected, but also human reviewers correctly recognized just 68% of the generated abstracts and wrongly flagged 14% of the original abstracts as generated [6]. These results are remarkable given that they were tested using ChatGPT out of the box. In other words, when the pre-trained model is fine-tuned with a dataset of examples from the relevant domains, the results will be enhanced. Further, as the underlying model (GPT-3.5) is continually being improved (e.g. updated to GPT-4 on 14 March 2023), the performance of ChatGPT is expected to also improve, as demonstrated in medical competency [7].

Whether such performance and behaviour constitute cognitive abilities and can be construed as intelligence of humankind is debated [8]. Indeed, human intelligence is a latent construct that does not yield itself to a straightforward measure in non-human animals and machines, not least because traditional intelligence tests such as Intelligence Quotient (IQ) are anthropocentric—designed specifically for humans. Even within human populations, IQ tests need to be significantly altered for testing in children and people with disabilities. Thus, to better understand the nature of AI and measure its progress in obtaining intelligence, much research is needed to define intelligence and measure it in a way that is comparable and fair across machines and mankind [9].

Given the controversy, the term intelligence will be used here to refer to artificial intelligence, regardless of whether that might be considered true human intelligence or not. Indeed, for practical purposes—that is, from an end user’s perspective—such debates are mostly moot so long as AI is able to get the job done. To appreciate the intelligence of AI, perhaps the most straightforward way is to have a conversation with ChatGPT (for a practical guide to its efficient use, see box 2). ChatGPT is strikingly human-like: it ‘understands’ text input and responds to it like a well-learned person—and in some ways, perhaps better than most people. The implications are likely to be profound, as the cost of intelligence has never been so low. This makes LLMs such as ChatGPT incredibly empowering for organizations and individuals.

Box 2. A practical guide to the efficient use of ChatGPT/Bard.

ChatGPT can be accessed through a web interface. To get started, go to the official webpage (<https://chat.openai.com>) and sign up for an OpenAI account (phone verification is required). Once logged in, you will see its interface, as shown above, where you will find example prompts to ask the chatbot and its capabilities and limitations. Interact with the chatbot by typing your prompt in the blank input bar (bottom) or initiating a new chat (top left).

To use it more efficiently, familiarize yourself with three key features. First, each prompt in your chat history has an edit button when you hover over it (on the right), where you can edit your previous prompt. After your edit, the chatbot will provide a new response accordingly. This is useful when your initial attempt does not yield the response you want. Second, you can provide feedback on the response (thumb up and thumb down icons, on the right) and you can ask it to regenerate responses (bottom)—which you can toggle to compare and find the most desirable one. Third, you may want to start a new chat for each project, as ChatGPT takes into consideration the chat history of each conversation.

Getting the desired results may require some thought. That is, feed it the right prompts (see six tips for writing effective prompts in the online supplemental materials: <https://osf.io/8vpwu/>). LLMs tend to make assumptions about user intent based on the prompt given, rather than asking clarification questions. To enhance accuracy, it is important to provide it with sufficient contextual information [10]. In general, prompts should be clear and concise. You can provide very specific instructions and offer feedback and new directions as follow-ups throughout the conversation. For example, you may ask it to explain a statistical concept by typing: ‘Explain Cook’s distance’. Suppose you find the response a bit dense. You can follow up by typing: ‘Can you explain it like I am five?’ As another example, you can feed it with your writing and ask it to make it more concise: ‘Please rewrite it to be more concise’. But if you find the rewrite a bit non-sophisticated, you can follow up with a prompt like: ‘Please make it more sophisticated for an educated audience’. You can keep fine-tuning it to your desire. However, if you have a clear goal, using an elaborate, specific prompt will work best. In fact, you can enlist ChatGPT to help improve the prompt (e.g. ‘Please evaluate each prompt I present and provide a rating on a scale of 1 to 5, based on its clarity and level of engagement. Kindly provide constructive feedback on how I can improve each prompt if necessary. Should the rating for a prompt be 4 or above, proceed to answer it; otherwise, create a new prompt that meets the desired criteria’).

ChatGPT is helpful for many things, from helping you learn, code, analyse and write to assisting with your teaching, mental needs and job applications. Ultimately, to get the most out of its capabilities, be creative and imaginative. Say you have written an emotional email. Before you send it, you can enlist ChatGPT to check its tone, using the following prompt: ‘Acting as an editor, please make recommendations on how to improve the email below using the principles and concepts of Nonviolent Communication (NVC). For each edit, please provide the rationale and some examples’. Indeed, you can ask ChatGPT to act as a simulated patient, therapist, coach, advisor, tutor, professor or interviewer—the possibilities are endless. Or consider your next job application. You can request ChatGPT to help craft a customized cover letter for the job, using a prompt like: ‘Please write a cover letter for the job description below using my CV that follows’.

Example screenshots of using R and Adobe Illustrator, tips for writing effective prompts, and a living resource are provided online (<https://osf.io/8vpwu/>). This guide also applies to the chatbot, Bard, which is highly similar to ChatGPT except for some minor differences (e.g. the ‘[r]egenerate response’ function in ChatGPT is replaced by the ‘[v]iew other drafts’ function in Bard).

For knowledge workers, it enables us to be more productive and efficient—doing more with less. A list of tips, examples and resources is provided online (<https://osf.io/8vpwu/>). For example, ChatGPT can provide explanations and help us learn a new domain more efficiently (e.g. ‘Act as an R instructor and teach me the basics’), write and debug codes faster (e.g. ‘Write R code to do a one-way ANOVA based on the following data’), assist with writing (e.g. ‘Rewrite the following paragraph to be more concise’) and more. By automating aspects of the research process and improving research efficiency, ChatGPT helps to accelerate the pace of scientific discovery.

From the perspective of philosophy of science, AI also has the potential to uniquely complement and enhance human intelligence in facilitating scientific inquiry and discovery. For one, by analysing and synthesizing vast amounts of data from different fields, LLMs may help to discover connections between seemingly disparate fields—connections that might not be immediately apparent to human researchers. For another, whereas human researchers are inevitably influenced by personal values and preferences, social norms and cultures, and historical assumptions and biases [11], LLMs do not have emotions, consciousness or

personal motivations. Indeed, by analysing vast and diverse amounts of data with the same algorithmic process, LLMs have broader perspectives and greater consistency than individual researchers, thus reducing the risk of cognitive bias, from confirmation bias to the availability heuristic. Moreover, although biases do exist in LLMs due to the training data and algorithms—a limitation discussed later—these biases are not identical to human biases and can help to counteract or reduce certain predispositions in scientific practices, potentially improving the reliability and objectivity of scientific inquiry [‘strong objectivity’; 12].

2.2. Versatile

As alluded to before, what makes generative AI such as ChatGPT special is that it excels not just in one domain but across many domains, thanks to the diverse training text data. ChatGPT has been trained to understand and generate cohesive text across a broad spectrum of subjects, from general knowledge to specific areas such as science and mathematics. It is proficient in a wide range of human languages (English, Spanish, French, German, Italian, etc.) and computer programming languages (Python, JavaScript, Java, C++, R, etc.). This versatility makes it useful in multiple capacities, such as a coach, research assistant and co-writer.

Consider the many tasks that researchers perform every day. In administrative roles, writing and editing documents and emails can benefit from ChatGPT. In teaching, generating questions and grading them, creating discussion points and questions, editing syllabuses and handouts—these are some common tasks that can also use help from ChatGPT. In research, too, practically all processes—other than those involving physical interactions—can enlist ChatGPT. Indeed, formal evaluations in finance research show that ChatGPT can significantly assist with idea generation, data identification and more. Incorporating private data and domain expertise can further improve the quality of the output [13].

For example, ChatGPT can help with familiarizing oneself with new topics (e.g. ‘What is generative AI’), summarizing (e.g. ‘Summarize the key issues mentioned below in a table, using two columns: ‘Ethical issue’ and ‘Key question’), coding (e.g. ‘The following code has errors. Can you advise how to fix it’), brainstorming (e.g. ‘Write five titles based on the following keywords’), providing feedback (e.g. ‘Act as a journal reviewer and provide feedback on the abstract below’) and more.

2.3. Collaborative

ChatGPT is also special for its conversational capability, thanks to a method called reinforcement learning from human feedback (box 1). This capability makes it an excellent collaborator, able to listen and update its responses based on user feedback. To illustrate, suppose we want to improve our writing. We can start with the prompt: ‘Act as a copy editor, revise the text below and explain your edits’. If we don’t like a particular expression in the revision, we can follow up with a new request: ‘Can you make ‘...’ more elegant?’ Indeed, we can ask ChatGPT to give the writing some personality, revise it for an academic audience, make it more persuasive or assertive, in the style of Hemingway, and so on. From proofreading to editing and rewriting, the possibilities are endless.

The utility of intelligent, versatile, always-on collaboration afforded by ChatGPT cannot be overstated. It offers a great channel to bounce ideas off of. It also helps to alleviate common drudgery and mental block—making research more fun. For example, regular expressions (regex or regexp) are a powerful tool commonly used in text analysis to define patterns for strings—thus enabling matching, extracting, and substituting patterns—but they can be complicated and error-prone. ChatGPT makes it much easier to use regex by helping researchers understand the syntax and usage (e.g. ‘How to replace all occurrences of Ph.D. with PhD in R using regex?’), and then construct or refine a regex (e.g. ‘Test the regex on a sample text and return the matched substrings’). Similarly, consider a common mental block: writer’s block. ChatGPT helps by brainstorming and collaborating with us, starting the first step that ultimately paves the way for a thousand-mile journey to publication (e.g. ‘Give me five ideas to begin an article on ‘how AI may help researchers’”).

3. Limitations of generative AI

As with any other tool, generative AI has limitations. These limitations are rooted in the principles and techniques that make it so powerful in the first place (box 1). Specifically, LLMs such as ChatGPT are language models trained on massive data. When they respond to queries and engage in conversation, they do not understand the content in the same way humans do, but rather make predictions about text based on patterns learned from training. They ostensibly write like an educated human—a great achievement—but they are not. This will become plainly clear once we interact with them in a deep manner (e.g. they can contradict themselves at times, and they do not have a strong grasp of context). The important point, however, is to use them as powerful tools rather than relying on them.

In the context of research aid—such as for a research project or for lecturing on a topic—a major limitation of LLMs is that they may fabricate facts, creating confident-sounding statements and legitimate-looking citations that are false (hallucination). Thus, as with any other source of information (e.g. Wikipedia), it is important to critically evaluate and verify AI responses, particularly when reliability is critical [14]. An important next step might lie in developing methods to quantify and signal the epistemic uncertainty and potential limitations of AI-generated results.

Still another limitation has to do with the training data for LLMs. These data are not—and cannot be—truly neutral or objective, but rather laden with assumptions and biases, ranging from political and ideological to cultural [12,15]. From the perspective of standpoint epistemology, such biases and assumptions are not inherently problematic. To the extent that knowledge is socially situated—different people have different experiences and perspectives that shape their understanding of the world—biases and assumptions can be understood as reflective of specific standpoints (i.e. perspectives) of the people who generated and compiled the data.

Yet, the challenge is that the standpoints represented in the training data may not be evenly distributed or representative of all perspectives. Indeed, the issue of underrepresentation in knowledge production has been widely documented, including the underrepresentation of certain racial, ethnic, gender, political and geographical groups as participants and researchers in medical and scientific research [16,17]. Lack of diversity in the research process

contributes to prejudices, stifles epistemological plurality, and limits the range of topics and questions being pursued [11]. In turn, biases and limitations in the data may be picked up—or even amplified—in LLMs. For example, when the training data predominantly reflect the views and experiences of certain groups (e.g. people from Western, educated, industrialized, rich and democratic societies), then the LLMs trained on these data will inevitably reflect these biases. This uneven representation can lead to a reinforcement of dominant perspectives and marginalization of others, creating a potential for bias in the outputs of these models.

There are additional limitations in using AI/LLMs to aid teaching and administrative tasks. In the realm of teaching, one potential use of AI is grading [18]. While such an application might seem promising in terms of efficiency, establishing a system that grades objectively, reliably and fairly presents significant challenges. To ensure fairness and accuracy, the AI's grading algorithms would need to be based on clear, comprehensive rubrics—a non-trivial task in itself. Even then, potential biases in the AI's interpretation of student work could lead to discrepancies in grading. Furthermore, nuances of student creativity and originality, which are often the hallmarks of exceptional work, might be overlooked or misinterpreted by an AI grader. Therefore, human supervision and verification are necessary safeguards in the grading process, potentially reducing the time and labour-saving benefits of the AI.

In the administration domain, AI is useful for drafting emails and similar tasks. While AI can be used to streamline the process and improve efficiency, it can also backfire in sensitive situations, when human touch is what matters most—something that cannot be replaced by AI. One case that underscores this limitation is a recent incident at Vanderbilt University, where two deans used ChatGPT to draft an email to students about a mass shooting at Michigan State University. Their use of AI in this sensitive situation led to their suspension, illustrating the potential pitfalls of over-reliance on AI for sensitive administrative tasks. Thus, striking a balance between leveraging AI's efficiency and maintaining the human touch that is often essential in academic settings will be an ongoing challenge in the implementation of these technologies.

4. Implications of generative AI: ethical use, equality and education

4.1. Ethical and responsible use

The power of generative AI such as ChatGPT raises many thorny questions regarding its ethical use, from plagiarism, image manipulation, authorship and copyright to fake research (table 2). It is one thing to ask it to act as an editor to correct language issues in our own writing, but quite another to ask it to write an entire paragraph and then copy it [2]. The former is similar to the services offered by other writing tools and university writing centres, while the latter is widely regarded as plain plagiarism. However, the boundary between acceptable help and too much help is not always clear-cut. When we feed ChatGPT with our own text and ask it to rewrite it, is that too much help to be considered ethical? Does the answer depend on the length of the text—and if so, how can we determine the proper boundary? The same questions apply to text-to-image AI (e.g. DALL·E 2, Midjourney, Stable Diffusion). Is it okay to use AI-generated images in the paper, or would that be considered plagiarism? And in the cases where AI offers 'too much' help, can it be listed as a co-author? Fundamentally, who has the right to claim copyright over AI-generated content (text, images, etc.): the prompt creator, the AI, the AI developer or the owners of the training data?

<<TABLE 2 OMITTED>>

These questions are important for the community to consider and address. Currently, publishers and journals are divided in their policy and stance on some of the questions. For example, Springer Nature does not allow LLM tools to be listed as authors, and requires researchers to document their use in the paper [19]. On the other hand, Science family journals not only ban AI tools as authors, but also prohibit the use of AI-produced content (text, images, figures, graphics) in the paper [20]. Although such swift decisions are understandable, going forward it is important to engage the whole scientific community to reach a more consistent and informed consensus. For example, banning AI tools as authors because of their inability to take responsibility flies in the face of the long-standing practice of posthumous authorship [1].

The more practical issue is that it may not even be feasible to detect AI-generated content with sufficient accuracy to be useful. Compared with typical AI-generated content, human-generated content generally—but not always—has higher burstiness, mixing longer or more complex sentences with shorter ones, and with higher perplexity, using words that are less expected [21]. However, some human writers do write with low burstiness and perplexity, posing a problem of false positives for algorithms. Moreover, LLMs can be instructed to write content with higher burstiness and perplexity, creating a problem of false negatives for algorithms. On top of that, given that LLMs are constantly evolving and improving, it is reasonable to assume that their ability to evade detection may do so as well. Thus, although algorithms for detecting AI content may be useful to compare different groups of writing, they are unlikely to be able to 'convict' any individual writing. Banning the use of AI-generated content may prove challenging to implement.

Fundamentally, if AI-created content is valuable, there is no reason to reject such content. From an epistemic point of view, we should not treat a finding differently just based on the status of the author, whether it is a Nobel-prize winner or a junior academic member. The identity of the author is irrelevant. The same applies to AI: if AI has valuable, original content, there seems no epistemic reason to devalue it just because it is created by AI. The real question is the vetting of its value—which rests on the human author and reviewers. Thus, a more pragmatic approach to AI in academic publishing is to encourage or mandate its transparent use [22] rather than banning it outright or even limiting it. From this perspective, there is no need to limit the amount or kind of help from AI—no concept of too much help from AI—as long as it is transparently reported.

Perhaps a more urgent issue with AI concerns its potentially serious threat to scientific integrity: the inevitable exponential rise of AI-generated, fraudulent papers submitted to scientific journals—some of which will pass peer review and become part of the scientific literature. Paper mills, which are already notorious for creating and selling fake research with fraudulent data and images, will become an even bigger threat when equipped with the unprecedented power of AI [10]. However, the negative disruptions brought about by AI, as with the advent of any other powerful tool in history, are to be expected. Indeed, more generally, if content that is not valuable or simply fake can pass peer review, whether it is from AI or not, the problem has more to do with the peer review system. The potential negative impact is not a cause to forbid or limit the use of AI, but a call to step up our efforts in implementing better practices in scientific review and publishing.

Such practices may involve the implementation of rigorous and open peer review (e.g. published peer review exchanges), collaborative review (e.g. discussions among reviewers and the action editor before making an editorial decision) and open science practices (e.g. open data and materials). These practices serve to deter fraudulent submissions, as through open review, the review process is subject to scrutiny by the wider scientific community; they also enhance the probability of detecting fraudulent content, as the accessibility of data and materials simplifies the process for others to validate the results. For these practices to be most effective, researchers need to be aware of the potential for AI tools to be used to generate fraudulent content, as well as to be alert to potential signs of such fraudulent content. Thus, education and awareness are vital. In addition, AI-based tools may be developed to detect patterns indicative of data fabrication or falsification, as well as to identify inconsistencies or errors in data analysis. Together, these strategies can help mitigate the negative impact of AI on knowledge production and improve the accuracy of the scientific record more generally.

4.2. Impacts on equity

Having discussed the strengths, limitations and ethical use of generative AI, a natural question arises concerning its implications for equity. Perhaps paradoxically, the availability of powerful, versatile AI tools can promote equality for some while amplifying disparities for others. On the one hand, a main contributor to global disparities in scientific research is language; for example, most mainstream journals are in English, bestowing a natural advantage on native English researchers [16,17]. LLMs can help level the linguistic playing field by offering a language boost for non-native English researchers through copy editing and other writing assistance (e.g. 'Act as a copy editor, proofread the following text for an academic journal, and highlight the changes at the end'). Thus, researchers previously disadvantaged in the English language can now compete on a more equal footing.

The innovation done by research institutions is at the heart of the U.S. economy.

Mayo 10 furthers

Merrilea Mayo, ITF, "Refueling the U.S. Innovation Economy:", 2010,

<https://d1bcsfjk95uj19.cloudfront.net/files/2010-refueling-innovation-economy.pdf> recut //ATC

Countries seek to spur more innovation for three primary reasons. First, innovation helps countries realize an economy characterized by a consistently improving standard of living, which can only be achieved by continuously increasing productivity levels. In fact, the U.S. Department of Commerce has found that technological innovation has been responsible for as much as 75 percent of the growth in the American economy since World War II.⁵⁶ Through its contributions to total factor productivity (TFP) and capital deepening, innovation appears directly responsible for at least 55 percent of U.S. productivity growth from 1959 to 2005.⁵⁷ Some studies have estimated that innovation drives up to 90 percent of per-capita income growth.⁵⁸ Additionally, differences in total factor productivity per worker explain 90 percent of the cross-country variation in the growth rate of income per worker.⁵⁹ Innovation achieves its impact by enabling the productivity improvements that lie at the core of economic growth; for example, the innovative use of information technologies has accounted for half of U.S. productivity growth over the past 15 years.⁶⁰

C3 -- Automation

There is an impending automation crisis.

Michelle Toh, 3-29-2023, "300 million jobs could be affected by latest wave of AI, says Goldman Sachs," CNN,

<https://www.cnn.com/2023/03/29/tech/chatgpt-ai-automation-jobs-impact-intl-hnk/index.html//EE6.6>.

Hong Kong CNN — As many as 300 million full-time jobs around the world could be automated in some way by the newest wave of artificial intelligence that has spawned platforms like ChatGPT, according to Goldman Sachs economists.

They predicted in a report Sunday that 18% of work globally could be computerized, with the effects felt more deeply in advanced economies than emerging markets. That's partly because white-collar workers are seen to be more at risk than manual laborers. Administrative workers and lawyers are expected to be most affected, the economists said, compared to the "little effect" seen on physically demanding or outdoor occupations, such as construction and repair work. In the United States and Europe, approximately two-thirds of current jobs "are exposed to some degree of AI automation" and up to a quarter of all work could be done by AI completely, the bank estimates. If generative artificial intelligence "delivers on its promised capabilities, the labor market could face significant disruption," the economists wrote. The term refers to the technology behind ChatGPT, the chatbot sensation that has taken the world by storm.

We can avoid catastrophe if we reskill

Emma Ascott, 12-24-2021, "Automation Versus Human Innovation: How to Engineer an Equitable Economy," Allwork.Space,

<https://allwork.space/2021/12/automation-versus-human-innovation-how-to-engineer-an-equitable-economy/>, accessed: 5-23-2023 //ZD

Artificial intelligence technologies have reduced repetitive work and enhanced work efficiency, and as a result, almost every industry in the world is planning to leverage AI or has already implemented it in their business. Despite the misconception that automation and AI decreases job opportunities, **it may actually prompt a huge spike in new positions.** According to the World Economic Forum Future of Jobs Report, **85 million jobs will be replaced by machines** with AI by the year 2025. While that statistic might make you uneasy, the same report states that **[but] 97 million new jobs will be created by 2025 due to AI.** The question is no longer whether AI will change the workplace; it's how companies can successfully use it in ways that enable – not replace – the human workforce. AI will help to make humans faster, more efficient, and more productive. What jobs will AI actually replace? It's true that **AI will threaten some unskilled jobs through automation, but it will also potentially create different kinds of jobs that require new skill sets that will be developed through training.** AI can be used in manufacturing to make processes more efficient while also keeping human workers out of harm's way. Opportunities to leverage AI and machine learning in manufacturing include product development, logistics optimization, predictive maintenance, and robotics. **In all likelihood, AI will take over jobs that require copying, pasting, transcribing, and typing.** In areas such as medical diagnosis, speech translation, and accounting, AI has outperformed humans in every way. But **AI will not be able to replace human judgment.** AI is just the most recent manifestation of ongoing workplace evolution. Finding the things that are worth teaching to the AI will still always be a job in the hands of humans. While this might not be true forever, AI isn't capable of developing complex strategies or thinking critically through complicated scenarios. There is a certain element of human intuition that's critical, and many people will turn to AI to assist them in thinking through problems – but ultimately, humans will make the decision. What jobs will AI create?

Link 1

Ai Training begins in the classroom

Frank Hamilton, 14 NOVEMBER, 2022, "How To Prepare Students To The Future With AI?," EuroScientist journal, <https://www.euroscientist.com/how-to-prepare-students-to-the-future-with-ai/>, accessed: 5-23-2023 //ZD

As AI becomes more prevalent in the world, educators should begin to prepare students for a future that will be increasingly reliant on this technology. The top six ways to prepare students for the future with AI Here is how you can help students prepare: 1. Teach them about the basics of AI One of the first things you need to do when preparing students for the future with AI is to teach them about the basics of AI. It includes what AI is, how it works, and some of its potential applications. **By teaching students about AI, you can** help them to understand how this technology will impact their lives and the world around them. Understanding the basics of AI will also **give students a better foundation on which to build more specific knowledge in the future.** 2. Help them develop critical thinking skills As robots become capable of carrying out tasks that humans have traditionally done, students must be able to think critically about the implications of this technology. For example, as robots become better at performing manual tasks, what jobs will remain for humans? Developing critical thinking skills now will equip students to deal with these complex questions in the future. 3. Encourage them to be creative Even though robots are becoming increasingly capable of doing things that humans can do, there are still many things that they cannot do. AI, for example, can generate text material based on input data. The results, on the other hand, will astound you with the number of logical and grammatical errors. If you seek proofreading or text editing assistance, visit writing services reviews websites such as Rated by Students. Furthermore, although it is produced in minutes, material produced by AI always lacks the creativity and unique charm found in the text produced by humans. This is where human creativity comes into play. It is still important that humans know how to be creative to be able to come up with new ideas and solve problems in innovative ways. Encouraging students to be creative now will help them to remain relevant in a future dominated by AI. 4. Show them how to use AI ethically Ethical concerns are often raised when discussing AI due to its potential for misuse. Students need to learn about responsible AI development and use cases. What are some principles for responsible AI development? What are some common ethical issues with AI? By answering these questions, students will be better prepared to use AI ethically. 5. Encourage them to experiment with AI tools **One of the best ways for students to learn about AI is by experimenting with AI tools themselves.** There are many free online resources available, such as TensorFlow Playground and IBM Watson Studio, that allow users to experiment with different machine learning algorithms without any prior experience required. **These tools can help**

students get a feel for how AI works and how it **can be applied** in different ways. 6. Inspire them with stories about people using AI for good. It is also important for students to see how AI is being used for good in the world today so that they are inspired to do likewise in their careers. For example, there are many stories of people using machine learning algorithms to diagnose disease, protect the environment, and enhance education access worldwide. Hearing about these cases can help show students how they can use their skills for good. Another example of how AI may benefit your students in the future is by providing useful insights during research or project work on a given topic. Students will be able to reduce the number of mistakes they make by using specialized AI tools. However, for more in-depth material proofreading, it is best to seek professional assistance. For example, from custom writing reviews websites such as Top Writing Reviews.

Conclusion **Preparing students for the future with artificial intelligence is essential if you want them to be able to thrive in an increasingly automated world. By teaching them about the basics of AI, helping them develop critical thinking skills, and encouraging them to be creative, you can give them the tools they need to succeed both personally and professionally.**

Foundational skills are essential

Anitta Jara, 2-9-2022, "The Role of Artificial Intelligence in the Future of Education," GetSmarter Blog, <https://www.getsmarter.com/blog/market-trends/the-role-of-artificial-intelligence-in-the-future-of-education/>, accessed: 5-23-2023 //ZD



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<https://www.getsmarter.com> › author › ajara2u-com

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The Role of Artificial Intelligence in the Future of Education · Education | Executive education · LSE MBA Essentials Online Certificate Course Trailer.

The World Economic Forum estimates that, by 2025, a large proportion of companies will have adopted technologies such as ML. They strongly encourage governments and educational institutions to focus on rapidly increasing related education and skills, focusing on both STEM and non-cognitive soft skills to meet the impending need. Advances in technology will cause major disruptions in the workforce, as automation could replace up to 50 percent of existing jobs in the U.S. alone, Microsoft reported.¹³ The Microsoft report continues, suggesting **students will need to have mastered** two facets of this new world by the time they graduate. They need to: Know **how to utilize ever-changing technology, such as AI, to their advantage**. Understand how to work with other people in a team to problem-solve effectively. Preparing students **to work alongside AI in the future** can start early. As many children are already comfortable with digital technology before entering school, **it's essential to teach them the skills to thrive in a digital workplace. The workforce of the future has its foundation in the now.** In the Oxford Artificial Intelligence Programme, you'll gain an understanding of AI and learn how it can be best implemented in your workplace. Expand your knowledge in this disruptive and transformative industry, and use AI to advance your business.

L2

Workers need to reskill and AI can help in the process.

Cane and Butterfield, 10-22-2020, "Here's how AI can train workers for the jobs of the future," World Economic Forum, <https://www.weforum.org/agenda/2020/10/ai-jobs///EE6.6>.

In other words, even with no further advances of AI, today's workers will face enormous disruptions as labour markets are transformed by automation tools already on the market. The challenge ahead will be even

greater for two reasons: First, COVID-19 has taken an enormous toll on the global economy, leading to an estimated loss of 14% of working hours or approximately 400 million full-time jobs in the second quarter of 2020. Second, far from remaining static, automation technologies are being developed and commercialized at an accelerating pace during the pandemic, and their capacities are expanding as they harness growing quantities of data, computing power, and experience. A positive future Despite these significant headwinds, AI holds great potential for workers and the future of labour. The Future of Jobs Report found that 97 new million jobs that are adapted to the new division of labour between humans and machines could be created by 2025. Instead of worrying about job displacement, we should get to work creating the new, high-quality jobs of tomorrow while massively expanding our upskilling and reskilling efforts to transition displaced workers into these new opportunities. This is where AI can help solve some of the very problems it helped create. Fortunately, a new cohort of purpose-driven AI innovators has begun mobilizing to ensure that workers around the world share not only in the risks that AI poses but also its powerful benefits. Here are four ways that AI is helping create a just transition to a positive future of work: 1. Invest in reskilling and upskilling Some AI start-ups are focused directly on reskilling and upskilling today's workers, using AI algorithms to create personalized training programmes that build on workers' existing skillsets to prepare them for future opportunities that leverage technology. For example, California-based EdCast combines a detailed assessment of workers' skills with data-driven analysis of future labour market needs, allowing users to identify potential future jobs and gain the skills and qualifications they need to secure them. 2. Embed learning into everyday activities Other innovators are focused on embedding learning into everyday work activities so that workers are continuously growing their skillsets and expanding their capacity to fulfil future workforce needs. For example, Canadian start-up Axonify has pioneered the idea of 'microlearning' in which employees spend three to five minutes per shift on learning and performance improvement activities that are matched to their individual needs by an AI algorithm. 3. Match workers to new opportunities While AI-driven reskilling can help prepare workers for the disruptions underway, there is still an enormous need to match workers to new opportunities being created. AI can help here too, and start-ups like SkyHive and Kalido have created AI-driven platforms that connect workers to new opportunities within and outside their current organizations, based on their individual skillsets, career goals, and retraining needs. 4. Prepare the next generation of workers AI is not only being used to future-proof today's workers and match them with tomorrow's opportunities but also to prepare the next generation of workers for a future disrupted and transformed by technology. Recent years have seen an explosion in AI-powered education technology (EdTech) tools to improve learning outcomes at the K-12 level, primarily in the developed world but increasingly amongst less privileged populations. For example, New Delhi-based start-up ConveGenius has targeted the 100 million students in India with the most limited access to quality teaching, using AI to assess each student's learning needs and deliver the educational content they need to succeed as workers and citizens. Scores of other start-ups are racing to address this significant business challenge and seize the opportunity to upskill and reskill workers for the future. AI as part of the solution No single technology will solve all the problems facing workers today. Achieving a just transition to a positive future of work will require smart government policies, ambitious corporate programs, and individual action by workers in addition to new technologies. But as we work to improve our responses to the disruptions underway, we should encourage innovators and entrepreneurs to focus on new ways to use AI technologies to empower the workers of today and create exciting new opportunities for the workers of tomorrow.

AI reskills in half the time.

Siva Prasad Nanduri, March 31, 2023, "Creating a future-proof workforce: Using AI for Upskilling and Reskilling," LinkedIn (TeamLease Digital),

<https://www.linkedin.com/pulse/creating-future-proof-workforce-using-ai-upskilling-reskilling/>,

accessed: 5-23-2023 //ZD

With technological advancement, several job roles are becoming obsolete. If the employees upskill or reskill as per the current requirement, it enhances their chances of employability. -It gives you better job security as many roles are being automated rapidly at the present time.

-Employees may future-proof themselves by upgrading their skills and meeting the expectations of changing businesses -Employees with trending skills and skills in-demand can contribute better in the organization, thereby improving the business outcome -Upskilling and reskilling in trending skills also contributes to the personal growth and development of the employees Considering the several benefits that upskilling and reskilling entail, it is essential to upgrade one's skills on a regular basis. The evolution of artificial intelligence technology is significantly facilitating the upskilling and reskilling of businesses and employees. On the one hand,

implementing AI at work will lead to increased productivity and efficiency, and on the other, it may take away some jobs that require redundant tasks. By automating repetitive tasks, AI will reduce the cognitive workload and also eliminate the chances of errors to a great extent. There are several AI-powered tools that are being developed to help employees to upskill and reskill and remain relevant in employment for a longer period of time. Why use AI for Upskilling/Reskilling of Workforce?

AI can be effectively applied to reskilling and

upskilling the workforce in almost half the time as compared to the traditional training

method. It has the potential to identify skill-gaps in each employee and act towards bridging

them. Key benefits of using AI for reskilling and upskilling the workforce- Train employees faster With AI-powered tools, businesses can upskill their workforce significantly faster and without much hassle. It also gives the employees the flexibility to access the data and resources as and when required. It goes hand in hand with work and empowers them to use the tools without wasting time on already known skills.

Preparing the next-gen workforce The rapid evolution of technology demands rapid skilling of the workforce. **AI helps in making the employees more adaptable to the changing work environment and thus preparing a modern**

workforce. Track employee progress With an integrated dashboard that keeps a record of employee participation, performance, and learning trajectory, one can easily keep track of progress. Attract and retain top talent In the current unpredictable world, it is a challenge for businesses to attract and retain their top talents. However, by using state-of-the-art training facilities, we may maximize the potential of each employee.

It also helps in retaining them for a longer period of time by making the employees more confident of the trending skills.

Artificial intelligence technology is improving the

training methodologies,

and thus businesses are eventually switching to AI-powered tools like online courses, chatbots, etc. for effective training. Virtual reality simulations are relevant in several industries, like research and healthcare, where employees can be efficiently trained to perform complex surgeries and perform research, etc. Likewise, gamified learning experiences are being worked on to teach concepts of coding in the form of games.

Otherwise millions would be in poverty.

Calum McClelland, 1-30-2023, "The Impact of Artificial Intelligence," IoT For All,

<https://www.iotforall.com/impact-of-artificial-intelligence-job-losses//EE6.6>.

In the past, the technological disruption of one industry didn't necessarily mean the disruption of another. Let's take car manufacturing as an example; a robot in automobile manufacturing can drive big gains in productivity and efficiency, but that same robot would be useless trying to manufacture anything other than a car. **The underlying technology of the robot might be adapted, but at best that**

still only addresses manufacturing AI is different because it can be applied to virtually any industry.

When you develop AI that can understand language, recognize patterns, and problem-solve,

disruption isn't contained. Imagine creating an AI that can diagnose diseases and handle medications,

address lawsuits, and write articles like this one. No need to imagine: AI is already doing those exact

things... The transition could be very painful. It's no secret that rising unemployment has a negative

impact on society; less volunteerism, higher crime, and drug abuse are all correlated. A period of high

unemployment, in which tens of millions of people [will be] incapable of getting a job because they simply don't have the necessary skills, will be our reality if we don't adequately prepare.

Rebuttal

No rebuttal evidence

