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QUESTIONS ABOUT LEARNING AND EDUCATION IN THE AGE OF AI

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OVERVIEW

This research-informed thought piece raises big existential questions about education in the age of AI, delves into the existing literature on AI and cognitive offloading, and weighs in on current debates in the field. The author also shares her own metacognitive journey of exploring how she thinks and learns and how she intentionally has and has not used AI as a tool for thinking and learning.

CONTENTS

INTRODUCTION: PROLOGUE

I set out to conduct a literature review on AI and cognitive offloading that bridges research and practice, and two things happened. Upon digging into the research, I realized it may be too soon to develop a comprehensive review on the topic. To date, there are not many studies on the topic that are grounded in empirical research; many are exploratory, and some are opinion pieces. While we are starting to learn about the impact of generative AI on cognitive skills, such as thinking, learning, remembering, and solving problems, the reality is that nobody knows the long-term effects. Then, in mid-January 2026, the Center for Universal Education at Brookings released a report that includes a literature review on AI and cognitive offloading. The Brookings report is currently the best resource on the topic that bridges research and practice.

As I started to dig into the literature on AI and cognitive offloading, it raised more questions than answers about learning and education in the age of AI. Some of the best thinking on the topic is from insightful news articles and Substack posts, and they are stirring interesting conversations and debates in the field. **In this research-informed thought piece, I explore the questions raised, delve into some of the existing literature, and weigh in on current debates in the field.** Working with AI and learning about this topic has led me on a metacognitive journey of thinking about how I think and learn and how AI could be a tool to enhance thinking and learning, and I share insights and lessons learned from this process.[1]

WHAT IS THE PURPOSE OF EDUCATION?

The disruption brought about by the advent of generative AI has raised big questions in the field of education. What is the purpose of education? Is it for academic learning? Is it to help students develop the knowledge and skills they need for further schooling or a career pathway of their choice? Is it for students to grow personally and in their social and emotional learning and development? The Brookings report argues that schools serve multiple interrelated purposes beyond academic learning, and I agree. In an ideal world, education makes meaningful contributions to students' academic learning, career readiness, social and emotional development, and overall personal growth. I watched an intriguing YouTube video of Claude campus ambassadors talking about AI on their university campus. One of the participants helped me to realize that students have their own reasons and motivations for being in school that may or may not include learning.

As the half-life of skills has declined in the age of AI and digital technology and will likely decline further, learning how to learn and to continue learning and adapting will be among the most important skills moving forward. Students will need to have a solid base of knowledge in math, science, and the humanities. Beyond that, students must

[1] According to Stanton, Sebesta, and Dunlosky (2021), metacognition is awareness of thinking for learning, and metacognitive knowledge includes "what you know about your own thinking and what you know about strategies for learning."

develop awareness, skills, and strategies to learn throughout their lifetimes. Demis Hassabis, CEO of Google DeepMind, said in September 2025 that the most important skill for the next generation will be "learning how to learn." Students will need to have the agency and self-efficacy to learn how they learn best and optimize strategies for continuous learning. In this context, teachers could serve as coaches and guides that support students in developing these learning and self-efficacy skills.

Depending on how it is used, AI could be a tool to enhance, deepen, and personalize learning, or it can be used in ways that hinder or completely bypass learning. I have used AI in ways to enhance, deepen, and speed up learning, and for me, it has been a continuous and iterative process of experimentation, evaluation, and reflection. However, I have had decades to learn without AI and to develop awareness of how I think and learn. For students who are early in their learning journeys, the process I am describing will be harder, but not impossible. They will need help and support from the adults in their lives, including teachers, parents and guardians, coaches, and mentors.

HOW WILL ASSESSMENTS NEED TO CHANGE?

Much has been written about how AI has exposed our broken assembly-line model of education based on rote learning, formulaic assignments, and rubric-driven grading.[2] Others have written eloquently about how it is rational for students to use AI to take advantage of a transactional model of education that awards grades for products.[3]

Deliverables and outputs, such as writing in an essay, used to be a vehicle through which students could develop and apply their thinking and learning. Now entire essay drafts can be generated easily and efficiently by AI. Before generative AI, writing required the use and orchestration of various cognitive processes and skills, including memory, problem solving, and critical thinking.[4] When writing, one must keep track of ideas while continuing to integrate new information. Writers must evaluate evidence, synthesize information, and strengthen arguments. Writing is built on language skills that encompass grammar, vocabulary, and syntax. Creativity in writing can come from taking ideas, facts, perspectives, and experiences and connecting them in different and unexpected ways. Writing is a way to apply and deepen thinking and learning.

Before generative AI, having students write an essay was a way to see if they were not only learning the content but also applying and orchestrating cognitive skills that are embedded in writing. However, a take-home essay as a standalone deliverable is no longer valuable as an assessment of thinking and learning.

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[2] Steven Mintz's article in Business Insider provides a great discussion on what this looks like in higher education.

[3] See When AI Replaces Thinking: The Erosion of Productive Struggle in Higher Ed for a thoughtful discussion on this topic.

[4] Minh (2024) pulls together the literature and discusses the various cognitive skills embedded in the act of writing, which I summarize in this section.

Educators have adapted and responded with workarounds, including in-class oral and paper exams. Some writing instructors have shifted to focusing more on the process rather than the product of writing, and they are checking in with students at various points to discuss and assess their writing process. As reported by NPR, high school English teacher, Chanea Bond, grades different parts of the process, including the thesis, outline, bibliography, and a handwritten draft, instead of grading only the final essay. Carlo Rotella, who teaches English at the college level, offers many ideas on developing an AI-resistant course in a recent New York Times article, including looking to "teachers of composition and creative writing [who] have been showing the rest of the profession that the path, not the destination, should be the goal." Rotella and others have adapted their assessments in a new world where students have easy access to generative AI.[5]

Similarly, for many STEM subjects, having students work through problem sets outside of class has traditionally been a way not only to see if they understood and were able to apply concepts learned in class but also to teach problem-solving skills.[6] However, problem sets are no longer valuable as a standalone assignment or assessment of learning if students can easily use AI to generate the answers. Whether with writing or STEM subjects, assessments of learning must shift so that students are required to actively engage with and apply the learning, explain and defend their thinking, and go over their process and workflow at various stages of the work.

HOW MIGHT INSTRUCTION SHIFT IN THE AI ERA?

Instruction in the age of AI will require a shift to more active learning in the classroom where students are engaging and participating, generating and debating ideas, applying and defending their thinking, solving problems, collaborating with peers, and receiving personalized feedback in real time.

AI can be an amazing tool to learn about almost anything. I am a fan of Google learning tools like Learn About and Google NotebookLM, which are grounded in learning science. AI offers new possibilities for personalized learning through the use of AI tutors designed by content experts and based on the science of how students learn.

In a 2025 study published in *Nature* by Kestin et al. (2025), researchers assessed a custom AI tutor that addresses the unique needs of each learner though timely feedback while adopting pedagogical best practices. The AI tutor was designed to facilitate active engagement, manage cognitive load, and promote a growth mindset. The researchers found that students learned significantly more in less time when using the AI tutor compared with in-class learning. The key to increased and more efficient learning, they believe, was from the AI tutor's ability to offer personalized feedback on demand. Rather

[5] In this article in *Fortune*, College professor, Nick Lichtenberg, talks about redesigning assessments for his computer science courses at Stanford.
[6] The MIT Teaching + Learning Lab provides insights and practical tips on rethinking problem sets in the world of generative AI.

than recommend that asynchronous AI tutoring replace in-class learning, they advise that AI be used to teach content material to students before class as in a flipped-classroom model, thereby allowing valuable class time to be used to develop higher-order skills such as problem solving and collaboration and to conduct learning assessments in real time. They write that "an AI tutor should not replace in-person teaching—rather, it should be used to bring all students up to a level where they can achieve the maximum benefit from their time in class." One caveat to note about this study is that the participants were students in an introductory physics class at Harvard, meaning that as a group, they likely had a relatively high baseline in terms of motivation, learning skills, and readiness to learn.

Though it may not work for all because there is variation in students' learning needs as well as in their motivation and readiness to learn, **there is potential for a flipped classroom model where students learn the content on their own with assistance from AI and then enhance and deepen their thinking and learning in the classroom through active learning**. I experienced this phenomenon recently as part of the Winter 2025 cohort of the AI Safety, Ethics and Society course through the Center for AI Safety. The content for the first week's course material was very technical. I used AI as a tool to help me understand the most technical concepts and ideas, and it got me to the point where I could engage more meaningfully in the class discussion. The facilitator has done a commendable job of designing the class time for active learning so that we must apply the learning through discussion and other interactive learning activities. The use of AI to learn in this case saved me time and allowed me to be more engaged during the interactive classroom time where we were required to apply the learning. However, I remember feeling apprehensive about relying on a machine to help me learn the course material rather than relying more on myself and on other humans, including the course facilitator or other students in my class.

Teachers or professors who are using valuable class time for passive lecturing only and assigning take-home essays or problem sets as assessments of learning skills should strongly consider a different approach. For many students, especially those who do not see learning as the main motivation for being in school but also for those who are simply busy, the temptation to use AI in ways that hinder rather than support learning is too much to resist. I appreciate this related insight from the Brookings report:

> For many students … [AI] provides seemingly correct answers, simplifies and accelerates completion of tasks that students perceive as difficult, and enables them to fulfill what many view as education's transactional nature—completing assignments for grades. Given this positive feedback loop and their developmental stage, many teenage students lack the executive functioning, metacognition, and self-regulation skills to recognize that learning involves friction and effort and that cognitive offloading poses both immediate and long-term developmental risks.[7]

[7] Burns et al., 2025, p. 58-59.

In the age of AI, education must pivot away from a transactional model that awards grades for turning in written assignments and products. That model is perfectly suited for students who choose to use AI to do the work for them and, as a result, bypass learning and thinking completely, ultimately inflicting great harm to their learning and development.

IS GENERATIVE AI JUST ANOTHER TOOL?

Generative AI is a tool, but it is a tool that can allow us to outsource our thinking if we let it. Nick Potkalitsky, a prolific writer and deep thinker in the field of AI in education, wrote a provocative piece on AI learning supports called "In Praise of Assistance" where one of his arguments is that the "difference isn't in the tool. It's in the design." AI is a tool, but it is not a tool like a calculator or a spell checker. The Brookings report notes that when students allow AI to do the work for them, the work that is intended to develop their core thinking and learning processes, they will be compromised in their ability to build foundational skills, including the ability to read, write, and think critically.

The MIT Media Lab conducted a fascinating study that showed the effects of generative AI use for essay writing on brain activity. The study by Kosmyna et al. (2025) divided participants into three groups: (1) one group wrote the essay with the help of a large language model (LLM); (2) the second group was allowed to use a search engine to look up information; and (3) the third group was allowed to use their brains only. The researchers measured the electrical activity in participants' brains during essay writing and found significant differences between the three groups, with more external support translating into less brain activity. The brain-only group showed evidence of greater cognitive processing and demonstrated deeper learning outcomes and more ownership of the work they produced. The LLM group experienced efficiency and less friction in completing the task, but it came at the cost of less memory recall, a lower proclivity to critically evaluate the LLM's outputs, and less ownership of the work that was produced. The search engine group came in between the LLM group and the brain-only group on these factors. The researchers concluded that the use of LLMs may "hinder deep cognitive processing, retention, and authentic engagement with written material. If users rely heavily on AI tools, they may achieve superficial fluency but fail to internalize the knowledge or feel a sense of ownership over it." The results of this study raise serious concerns about the long-term implications of overreliance on LLMs on cognitive abilities and skills.

While generative AI is not just another tool, we should not use sight of the fact that in the end it *is* a tool. It is a tool that can be used to either enhance or harm learning, depending on how it is developed and deployed. An LLM that is designed to produce outputs and answers quickly and efficiently with the least amount of friction possible is different than an AI tool that is designed and optimized for learning by managing cognitive load, facilitating active learning and engagement, adapting to individual learners' needs, and providing personalized feedback in real time. If knowledgeable and highly trained educators were to deploy such a tool in a thoughtful and sustained way, the impacts for student learning could be considerable.

WHAT IS THE ROLE OF CONTENT KNOWLEDGE IN THE AGE OF AI?

The advent of generative AI reintroduced an ongoing debate in education about the importance of focusing on learning skills, mindsets, and competencies over content knowledge. Within education, it has become passé in some circles to talk about the importance of content knowledge in an era when so much knowledge is freely available and right at our fingertips through digital technology. In an insightful piece, Robert Pondiscio argues that content knowledge is still critically important. Citing the ideas of E.D. Hirsch, he says that skills without knowledge are "empty vessels." Pondiscio acknowledges that information is readily available in the digital age, but to be able to use it, we need to have a repository of knowledge. He makes this biting observation about people who are under the illusion of mastery without doing the hard work of thinking and learning:

> The very people most likely to misuse AI—those with shallow background knowledge, weak discernment or motivation—are the ones most susceptible to its illusions. It's a knowledge amplifier, not a knowledge substitute. Education is not a product to be delivered; it's a transformation that occurs through effort. The problem with AI is that it can perform education's outputs—essays, analyses, answers—without any of its inputs. In sum, it is a powerful tool in the hands of the curious and the motivated but devastating to those merely seeking a shortcut.

Beyond the ongoing debate in education about the importance of content knowledge, there is also a relationship between content knowledge and domain expertise. If what is happening in the field of computer programming is an early indicator of what it is to come in other knowledge fields, humans will eventually shift toward overseeing the work of AI and AI agents rather than doing much of the knowledge work themselves.

Anthropic's Societal Impacts team conducted and shared the results of a study on how AI is changing the way engineers at Anthropic work, and it offers a fascinating glimpse of potential changes to come in the broader labor force. The engineers said their jobs have changed where they are now managing a group of AI agents. Evaluating AI outputs and overseeing the work of AI agents requires critical thinking and domain expertise. A Microsoft-affiliated study looking at the impact of generative AI on critical thinking by Lee et al. (2025) revealed that knowledge workers engage in critical thinking when using AI tools primarily to ensure the quality of their work, which is difficult when they are working in unfamiliar domains.

Domain expertise encompasses domain-specific content knowledge and skills. It is much harder to think critically and to verify AI outputs without expertise in a particular domain because without it, you don't know what you don't know. It will be challenging for early-career professionals to find and progress in a job without building domain expertise, which requires the acquisition of content knowledge and skills in a specific area. Alternatively, creativity can come from having a broad base of knowledge and experience

that allows for connecting ideas and perspectives on different topics and subject areas. These are arguments for developing a knowledge base with both breadth and depth.

Even in the age of AI and digital technology, content knowledge matters. We will need to draw from a repository of both deep and broad content knowledge to be able to think critically and creatively. Factual content knowledge may matter now more than ever as AI makes it easier to produce and disseminate disinformation and misinformation at scale. As AI becomes more advanced, we will also need a deep and broad base of content knowledge to be able to grapple with issues related to AI safety, ethics, and society. These are important topics that require deep and critical thinking by humans that we cannot outsource to machines.

WHAT ARE THE CHALLENGES AND OPPORTUNITIES OF AI IN EDUCATION?

AI technology is evolving incredibly rapidly, leaving insufficient time for our society and institutions, including education, to adapt to the changes. As digital natives, students are early adopters of AI technology. Based on their AI in education trends report, CopyLeaks reported in September 2025 that nearly 90 percent of students have used AI for academic purposes, and almost a third (29 percent) use it daily. Similarly, the Claude campus ambassadors said that most, if not all students are using AI on their university campuses. **Instructors, schools, and districts are struggling to learn about the technology while trying to adapt in real time to the rapid changes, which means we are flying the plane while building it and while it is flying at top speed.**

The risks are real. Overreliance on advanced AI can result in human enfeeblement. We risk becoming like the humans on hoverchairs in the movie, WALL-E, who are completely reliant on robots. The studies I cited in this paper point to the risks of overreliance on AI, which may result in a decline in a variety of cognitive skills. For students, using AI as a crutch can lead to a loss of intellectual autonomy and the stunting of critical thinking, problem solving, and recall skills that are yet to be developed. The Brookings report argues that the risks of AI currently overshadow the benefits because the risks undermine children's foundational development cognitively, socially, and emotionally. For workers, overreliance on AI can result in deskilling and the steady loss of deep knowledge and expertise over time. The engineers in the Anthropic study said that Claude enabled them to broaden their skills and increase productivity, but some staff were concerned about the decline of deeper knowledge and skillsets. One engineer said: "When producing output is so easy and fast, it gets harder and harder to actually learn something." Some engineers said that Claude is now the first go-to source for questions rather than other colleagues, with some reporting fewer mentorship and collaboration opportunities as a result**. In the workplace and in schools, if we are not careful and intentional, the use of AI and other digital technologies will result in the loss of human connection.**

Another important topic is AI's potential to help close or exacerbate existing inequities in education. AI could usher in personalized learning that levels the playing field for those who are furthest from opportunity. As Potkalitsky points out, AI can provide

assistance and feedback to students in under-resourced schools who rarely receive it. However, if privileged students in highly resourced schools receive the best human and AI supports whereas low-income students in under-resourced schools get limited human assistance and lower-quality AI supports, then inequities in education will deepen and widen.

While the challenges are many, we are standing at the precipice of a unique and unparalleled opportunity. Our outdated factory model of education based on rote memorization and formulaic assignments and assessments isn't working for anyone. Here I am reminded of an insight by Ying Xu, Assistant Professor at the Harvard Graduate School of Education, who said: "That's why we need to shift the narrative — not by asking how we can fit AI into education, but by starting with the end goal: What learning outcomes do we want to achieve, and can AI meaningfully contribute to them?" Which brings us back to the question about the purpose of education. What do we want to achieve? What is the overall goal or mission, and how can we use AI as a tool to help us achieve the outcomes that will enable us to achieve the overall goal or mission? If the goal of education is to meaningfully contribute to students' academic learning, career readiness, social and emotional development, and overall personal growth, then how can we use AI thoughtfully and strategically as a tool to help us achieve these outcomes?

We need to collectively figure out what education is for in the age of AI and change the incentives by making it less transactional. The advent and disruption brought about by generative AI provides us with a unique opportunity to address long-standing problems in our educational system. Even with its myriad risks, AI is a transformative technology with vast potential benefits for humanity and society. Rather than using AI to automate bad processes and make a broken system more efficient, let's take this opportunity to think collectively about how it could be used to reinvent and transform education and learning.

Moving forward, students and everyone else will need to take responsibility and have agency for their own learning. It will be important to get students to realize the benefit of understanding how they think and learn and to use AI in ways to enhance rather than harm their thinking and learning. There are opportunities to get students to reflect on and learn about how they think and learn. Interacting and experimenting with AI, learning about its strengths and limitations, and assessing and evaluating how one learns with and without AI has deepened my own understanding of how I think and learn. Helping students navigate this journey could be an important role for the teachers and other adults in their lives.

Tech companies can do their part to develop AI tools based on the Science of Learning and our evolving understanding of how students learn in the AI era. Despite such efforts by tech companies, students could still use AI tools and platforms that are not designed to optimize learning but rather to quickly and easily complete tasks and produce outputs—tools, as Carl Hendrick states, that "harm rather than enhance learning." This is where instructors will need to change assessments away from deliverables and products and toward assessments that get students to explain and defend their thinking and actively

apply the learning. Any high-stakes written exams should be in class where the use of AI and any electronic devices is prohibited.

Over time, I see the role of teachers evolving to become learning designers and coaches who help students learn how they learn and offer strategies for ongoing learning, adaptation, and resilience in the face of a rapidly changing world. Stanton, Sebesta, and Dunlosky (2021) argue that supporting the development of metacognition, which encompasses awareness of one's own thinking and strategies for learning, is a powerful way to promote student success in school. In a January 2026 announcement about their partnership with Teach For All to launch a global AI training initiative, Anthropic said that as "AI transforms how knowledge is created and shared, teachers will be essential guides for students navigating this transition." Teachers and other adults in students' lives will also need to play a critical role in helping to encourage and inspire students' curiosity, motivation, and engagement as learners.

There have been long-standing systemic problems with education, and generative AI is shining a bright light on those problems. There is an opportunity to transform education and learning, but it will take educators, advocates, researchers, policy makers, ed tech developers, students, and parents coming together to ask and address hard questions, including the questions raised here. Organizations are doing their part to facilitate these conversations. The Center on Reinventing Public Education (CRPE) launched the Think Forward AI Fellowship to accelerate collaborative engagement among education policy leaders, researchers, ed tech experts, and advocates. The Fellows convened in November 2025, and key findings from the discussions and sessions are outlined in this white paper.

I have been serving as a thought partner to Robin Lake, Director of CRPE, and collaborating with the CRPE team on the development of Think Forward: Learning with AI. To be an effective thought partner to a leading expert on AI in education requires me to read, learn as much and as quickly as I can, and think deeply and critically. For me, it has been a tremendous catalyst for learning on this important topic, and I appreciate the opportunity. I took on this challenge because I know how I learn, and I knew this would be a mechanism for me to learn, in some ways, more than I ever have in a relatively short amount of time.

WHAT ARE SOME DIRECTIONS FOR FUTURE RESEARCH?

Moving forward, we need more studies based on empirical research that examine the impact of AI on cognition and metacognition over the long term. Studies could examine the following questions:

- Does AI use lead to cognitive decline, and if so, under what conditions?
- What could be done to prevent cognitive decline from cognitive offloading?
- How do we use AI tools to enhance and augment human thought rather than replace it?

- How can AI be used to support not only personalized learning but also deep learning and collaborative learning?

Thank you to Robin Lake for sharing the first two questions. I heard the third question raised by Drew Bent in a panel discussion by Anthropic staff on AI in education, and it resonated.

Generative AI is bringing the Science of Learning into the spotlight, and it will be important for ed tech companies to integrate pedagogical principles into AI tools and platforms for education and learning. It is exciting to see companies like Google integrate learning science, or the best of what we know about how people learn, into their products. However, we cannot rely only on knowledge of how students learn in the pre-generative AI era. The Science of Learning will evolve as we learn more about AI and its effects over the long term on cognition and metacognition.

Learning and how we learn will increasingly be mediated by machines, and there are opportunities to learn from the field of AI epistemology. This article from *The Conversation* gave me insights into the field of AI epistemology. Epistemology is the study of knowledge and how we know what we know. AI epistemology grapples with new questions about how knowledge is produced and transferred. For many people, learning is now mediated by machines through AI platforms and tools that are being developed by tech companies. For centuries, our system of education was based on human-to-human knowledge transfer. Kimberley Hardcastle, expert in AI epistemology, states in the article: "Generative AI doesn't just change what students learn but fundamentally alters how they come to know anything at all." Generative AI will fundamentally change how many people, including students, think and learn.

AI is a tool that can fundamentally alter what we learn and how we learn, not only cognitively but also socially, meaning that AI can affect learning as a social process if learning is increasingly mediated by machines.[8] Edtech Insiders' Substack has an informative series of posts that make the case for Social AI and developing and deploying AI in a way that strengthens relationships and facilitates collaboration. The use of AI in education in ways that enhance and support human connection will be another important area of future exploration and study.

CONCLUSION: EPILOGUE

AI is here, and more advanced AI is coming. Let's be thoughtful and intentional in calling for and collectively working toward safe, reliable, and ethical AI that is aligned with human values and objectives and supports human flourishing.

In the context of education, most if not all students are using AI. We should not disregard the risks and challenges, but let's focus on the opportunities. How do we

[8] See Felice et al. (2022) for an in-depth discussion of learning as a social process.

harness the potentially transformative benefits of AI while mitigating the risks? While it acknowledges the risks of AI in education, the Think Forward newsletter recognizes that AI is here to stay, and I appreciate that it focuses more on the opportunities than the challenges.

I started off by talking about the literature review on AI and cognitive offloading that I had planned to write. I will continue to work on it as an ongoing project. After doing this work, I am inspired to regard it more as a process to deepen and understand my own thinking and learning rather than seeing it primarily as a deliverable as I might have in the past.

For this research-informed thought piece, I purposely tried to use the least amount of AI possible as a meta-experiment into my own writing process, and for the first time in a long time, I experienced writer's block. Not relying on AI as a readily available thought partner and writing assistant increased my cognitive load, introduced more friction into the process, and decreased my productivity as I took the time I needed to write and rewrite each section. It felt uncomfortable and frustrating at times, and it gave me more empathy for students who may be using AI because they don't want to sit with the discomfort of having writer's block. At the same time, not relying on AI through this process forced me to grapple with my thoughts and ideas and think through what I want to say, and it allowed me to say it in my voice. **Educators may need to encourage students to sit with discomfort and push through the process of learning or writing without AI. There will be friction, and the rewards will not be immediate. However, students will be making a critical, long-term investment in their cognitive development, and the gains they will make in their learning and higher-order thinking skills will compound over time.**

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