REL Central Ask an Expert Handout: Summary of Key Findings Related to Artificial Intelligence for School Turnaround

A REL Central partner expressed interest in learning how state education agencies (SEAs) and local education agencies (LEAs) have used AI strategies to support school turnaround and how those strategies influence student and teacher outcomes. This memo summarizes the limited literature scan REL Central conducted in response to this request as part of an Ask an Expert project. The content of this memo supplements the findings included in the accompanying slide deck. This work was funded by the U.S. Department of Education's Institute of Education Sciences (IES) under contract 91990022C0015, with REL Central, administered by Mathematica. The content does not necessarily reflect the views or policies of IES or the U.S. Department of Education, nor does mention of trade names, commercial products, or organizations imply endorsement by the U.S. government.

Study details

For education leaders working to improve chronically underperforming schools, understanding how AI is being used—and the evidence behind it—may help unlock strategies to improve teaching quality, personalize learning, and accelerate student achievement. AI refers to computational systems that can perform complex tasks typically associated with human intelligence, such as learning, reasoning, problem solving, perceptions, and decision making. In education this may look like techniques to adapt instruction, assess student learning in real time, tailor feedback, or support educators' decision making. School turnaround strategies have a wide aim to improve outcomes rapidly, typically within three years, and may focus on schools, teachers, or students. The research questions included:

1. How have SEAs, LEAs, and schools used AI to support school turnaround strategies, particularly as they relate to math tutoring, student supports, and instructional practices?
2. To what extent have AI-supported school turnaround strategies influenced school, teacher. and student outcomes (such as resource optimization, teacher knowledge and behaviors and student achievement and growth)?

To identify how SEAs and LEAs are using AI for school turnaround and related impacts, REL Central searched the following sources: the IES website, What Works Clearinghouse, Education Resources Information Center, and state education department websites for empirical research on AI and school turnaround or student or teacher outcomes. The search identified 48 sources for the scan, all of which described approaches that could plausibly be used in turnaround contexts as well as evidence of impact on school, teacher, or student outcomes. Twenty-two sources described how SEAs and LEAs were using AI, and 26 sources described related outcomes or impacts. Of those 26 sources, 22 reported evidence based on causal research designs (randomized controlled trial [RCT] or quasi-experimental design [QED]), while the remaining four reported evidence from descriptive studies focused on teacher outcomes. The findings are summarized below.

How have SEAs, LEAs, and schools used AI to support school turnaround strategies?

SEAs, LEAs, and schools use AI for predictive modeling of student outcomes, tutoring, and curriculum and professional development tools.

SEAs, LEAs, and schools in three states have used AI models to predict student outcomes.

- The Kentucky Board of Education provides three measurement and data visualization tools for free to districts: Early Warning System, Insights, and Persistence to Graduation.
- Four districts in New Mexico—Farmington Municipal Schools, Raton Public Schools, the Carlsbad Municipal School District, and Hobbs Municipal Schools—are piloting a text-messaging AI tool by Edia to address chronic absenteeism.

- Texas A&M University created a machine learning software, the District School Performance Predictor, to predict student scores on the State of Texas Assessments of Academic Readiness. LEAs and schools work with Texas A&M to review student data and identify areas for student improvement.

SEAs, LEAs, and schools in five states have used intelligent tutoring systems.

- The Iowa Department of Education and Aldine School District in Texas implemented Amira, an AI-powered reading tutor designed to aid emergent bilingual students and K–3 learners.
- The Arizona Department of Education and Newark Public Schools in New Jersey have implemented Khanmigo, a chatbot tutor for students and assistant for teachers.
- The Indiana Department of Education awarded grants to 112 schools to pilot their choice of AI platforms for high-dosage tutoring in the 2023–2024 school year.

SEAs in two states are piloting AI-enabled curricula and professional development tools.

- The Massachusetts Executive Office of Education launched The Future Ready: AI in the Classroom pilot, a yearlong professional development pilot for 45 high school educators across the state. In a second related pilot, educators participating in Future Ready are piloting AI curriculum in classrooms across 30 school districts.
- The Connecticut State Department of Education (CSDE) launched the K–12 Digital Citizenship Curriculum to prepare students for AI instruction. The curriculum provides educators with evidence-based materials aligned with state standards. CSDE also launched the AI Pilot Program, which brought state-approved AI tools to seven school districts from January to June 2025 and provided professional development to educators to bolster AI tool benefits and assess impact.

To what extent have AI-supported school turnaround strategies influenced school, teacher, and student outcomes?

Districts, schools, teachers, and students have seen benefits from integrating AI into their work, including more effectively allocating district or school resources; accurately predicting student success or risk; greater knowledge gains for teachers from professional development; and increased student engagement and achievement.

Deep learning models can help schools and districts allocate resources more effectively and accurately predict student success, although machine learning algorithms may perform on par with traditional early warning systems.

Deep learning models can shed light on more effective ways to allocate resources or staff. Such models use neural networks to identify patterns from raw data and outperform traditional (non-AI) methods for optimizing how schools allocate resources, staff, and materials, according to two studies using data from China. Deep learning proved more effective than traditional methods at allocating resources fairly and improving teaching quality when applied to school data from six regions (Zhao, 2025). Similarly, applying a deep learning evaluation system to data from 13 districts across one city showed that the number of districts that achieved "very good" or "good" levels of resource allocation increased from three to 12 districts after optimization (Liu, 2025).

Deep learning models can predict student success and near-term academic risk accurately, but machine learning algorithms may not enhance traditional early warning systems. Studies in Turkey showed that deep learning models can accurately predict students' course or assessment scores (Kapucu et al., 2024; Yildiz & Börekçi, 2020). Moreover, a machine learning algorithm can effectively predict when students are at near-term academic risks, based on integrated data involving students' prior academic problems, social services involvement, justice system involvement, and child welfare events (Bruch et al., 2020). However, machine learning algorithms may do no better at predicting at-risk students than traditional early warning systems (Cattell & Bruch, 2021).

Although teachers value and use AI, strong evidence of its impact on student learning is lacking, though emerging research suggests AI-driven professional development can support better instruction.

Teachers use AI to generate lesson content, develop assessments, provide feedback to students, and analyze student behavior as well as for differentiation strategies, resource recommendations, and augmented or virtual reality experiences (Wang & Guo, 2023; Tan et al., 2025). Preservice teachers report that they understand the importance of AI, perceive it to be effective, and use intelligent tutoring systems and smart content to design instruction (Al-Shammari & Al-Enezi, 2024; Filiz & Gür, 2025). However, research has not established which teacher uses of AI translate into improved learning outcomes for students.

AI-driven professional development programs may lead to better instructional practice. When teachers participate in AI-driven virtual training platforms for professional development, they are more likely to master content and provide coherent instruction (Copur-Gencturk et al., 2024; Yousef et al., 2024). One study found this is true when enhancing teachers' Smart Board skills and utilization (Yousef et al., 2024). Another study showed that AI-driven professional development helped middle-grade math teachers select cognitively demanding math tasks and provide more coherent mathematics instruction (Copur-Gencturk et al., 2024).

Students are using AI in a variety of ways, and tools such as intelligent tutoring systems, AI-driven instruction, and smart content creation show promise for boosting achievement and engagement.

Students are using ChatGPT to search for information, find answers, ask for feedback or tutoring, monitor their progress, and personalize their learning (Alkan, 2024; Debets et al., 2025; Satir & Korucu, 2023). However, students may not know how to verify the information they receive from AI, pointing to a critical area for skill development to help students make the most of these tools (Wang & Guo, 2023).

AI tools that provide personalized and interactive learning support have moderate effects on student learning outcomes. One meta-analysis and two reviews of existing research have summarized the impacts of AI on student outcomes across 82 unique studies with QED or RCT designs. AI tools including personal tutors, intelligent support for collaborative learning, and intelligent virtual reality had an average effect of 0.503—a positive, moderate-to-large effect for education—on student learning across 46 studies (Younas et al., 2025). AI applications such as chatbots, virtual reality modeling, virtual reality labs, flipped courses, gamified courses, augmented reality, and peer tutoring assistants in STEM and science classes have been found to support student learning, increase engagement, and reduce cognitive load (García-Martínez et al., 2023; Gunsaldi et al., 2025).

Intelligent tutoring systems lead to more engagement and improved learning, but assessment gains are inconsistent. Four causal studies looked at using AI to support student outcomes in math classes while three other causal studies looked at using AI to support student outcomes in English and visual arts courses. No clear pattern emerged by country or grade level, but positive effects were reported across diverse subjects and AI tools, suggesting that intelligent tutoring systems can enhance learning and engagement in varied contexts.

Six of the seven studies found that students using an intelligent tutoring system improved learning more than students using traditional instruction models. Improved learning included answering more questions correctly, receiving higher grades on homework, solving more word problems accurately, as well as demonstrating improved math proficiency, better grammar, and better performance (Chen et al., 2025; Henkel et al., 2025; Kara, 2025; Liu et al., 2025; Thomas et al., 2023; Vanzo et al., 2024). Four of the seven studies found that students using an intelligent tutoring system engaged more than students using traditional instruction models. Engagement included time practicing math skills, expressing interest in solving word problems, expressing satisfaction with and sustaining interest in AI support, and enjoying the content (Kara, 2025; Liu et al. 2025; Thomas et al., 2023; Vanzo et al., 2024). By contrast, the two studies that examined end-of-course exam performance found no significant differences between students using intelligent tutoring systems and those who did not (Chen et al., 2025; Eteng-Uket & Ezeoguine, 2025). Table 1 describes the tutoring systems used in these studies and the key findings, and the appendix describes the study design and sample size for each.

Using Tutor CoPilot or AI to deliver lessons or create videos lead to positive outcomes, but gamified applications may not. Other than intelligent tutoring systems, four AI uses were tested, using rigorous designs, to understand their impact on student learning. These included tutors using chatbots to improve their instruction, students learning from AI instructional agents delivering lessons, students using AI to create videos, and students using AI-based gamified applications. Tutor CoPilot—a real-time assistant that helps tutors provide expert tutoring to students—has been shown to help students pass their

exit tickets compared to students with tutors who did not have access to the assistant (Wang et al., 2024). The findings were even more substantial for students with tutors with lower initial expertise in the subject (Wang et al., 2024).

When comparing students using an AI instructional agent capable of delivering lessons to students with a traditional course instructor or an online course, students using the AI instructional agent felt they had more control over their instruction, interacted more with the content, and outperformed students in the online and traditional courses (Qin et al., 2025). Moreover, students using AI-based applications to help them create educational videos had higher average post-test scores on higher-order thinking and achievement than students who did not use the applications (Almelweth, 2022). Finally, no noticeable differences on student learning outcomes or motivation were found when comparing a class using Class Dojo, an AI-based gamified application that develops motivation among students learning science, and a traditional science course (Bani Ahmed, 2024).

Table 1. Intelligent tutoring systems lead to more engagement and improved learning

Author (Year)	*Country*	*Subject*	*Tutoring system*	*Key findings*
Henkel et al. (2025)	Ghana	Math	Rori	Students participating in tutoring with Rori answered 3 more questions correctly, on average, than students who did not participate in the tutoring, with a corresponding effect size of 0.36.
Chen et al. (2025)	United States	Math	Proof-Review-AI-Tutor	Students using the tutor scored 3 percentage points higher on their homework grades than students who did not use the tutor. No significant impact on students' performance on the exams.
Thomas et al. (2023)	United States	Math	Human–AI hybrid tutoring	Introducing math teachers and human–AI tutoring led to students spending more time practicing skills and improved proficiency.
Liu et al. (2025)	China	Math	ChatGPT-supported Mathematics Problem-Solving System	Students using the tutor solved more word problems accurately, were more likely to be engaged, and sustained interest longer than students who did not use the tutor.
Vanzo et al. (2024)	Italy	English	ChatGPT tutor	Students who received support from GPT-4 were slightly more likely to see gains in grammar and engagement and reported satisfaction and sustained interest.
Kara (2025)	Turkey	Visual arts	CoPilot and ChatGPT tutors	Students using the chatbots enjoyed the content more and performed better than their classmates who did not use these tools.
Eteng-Uket & Ezeoguine (2025)	Nigeria	English	Chatbot tutors	No discernible differences between the two groups regarding their end-of-course exam scores or their engagement.

Conclusion

AI models can help allocate resources more effectively and accurately predict student success, but some may not enhance early warning systems. It is possible to use predictive models (regressions or large language models) to identify schools that need support and the areas they need support in. These could include inputs using generative AI to process unstructured text (such as school board transcripts or notes or interviews). It is also possible to use deep learning models to assess fair resource allocation and teaching quality.

Although research has not established which teacher uses of AI impact student learning, emerging research suggests AI-driven professional development can support better instruction. Teachers can use AI to generate personalized content, analyze learning behavior, support design, or recommend resources. Schools and districts could consider implementing AI to support professional development offerings, as these have been shown to lead to positive teacher outcomes.

Intelligent tutoring systems and AI-driven instruction or other learning supports to create content show promise of increasing student achievement and engagement. Personal tutors, intelligent support for collaborative learning, and augmented or virtual reality each have been shown to have moderate effects on student learning. Moreover, intelligent tutoring systems and other AI-driven learning support have demonstrated impacts on students' homework completion, understanding,

and engagement. Math AI supports included Rori, Proof-Review-AI-Tutor, a ChatGPT-supported Mathematics Problem-Solving System, and human–AI hybrid tutoring, while non-math supports included Tutor CoPilot and other chatbot tutors or instructors.

Additional resources

- Student Achievement Partners' Guide to Integrating Generative AI for Deeper Math Learning summarizes specialized AI tools for math.
- The Learning Agency's Automated Student Assessment Prize (ASAP) 2.0 evaluates large language models on their ability to score student-written essays, a crucial capability for supporting educators and providing timely feedback to students.
- Edtech Insiders' Gen AI Use Cases in K-12 Education is a market map that features specific use cases for AI instructional materials, assessment and feedback, teacher practice support, teacher professional development, student support, and social tools.
- The Stanford AI Hub for Education's Research Study Repository synthesizes descriptive research and impact evaluations of AI use cases in education.
- The Center on Reinventing Public Education's AI Early Adopter Database tracks districts at the forefront of AI adoption and how they are using and piloting AI, the challenges they face, and what others can learn.

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Appendix. Summary of studies

Title	Authors	Year	Location	Intervention	Methods	Size	Findings
Districts and schools							
Identifying Students At Risk Using Prior Performance Versus a Machine Learning Algorithm	Cattell & Bruch	2021	United States	Machine learning algorithm	Predictive modeling	~24,000 students	No difference
Using Data from Schools and Child Welfare Agencies to Predict Near-Term Academic Risks	Bruch et al.	2020	United States	Machine learning algorithm	Predictive modeling	~30,000 students	Positive
Predicting Secondary School Students' Academic Performance in Science Course by Machine Learning	Kapucu et al.	2024	Turkey	Deep learning	Neural networks	445 students	Positive
Predicting Academic Achievement with Machine Learning Algorithms	Yildiz & Börekçi	2020	Turkey	Machine learning algorithm	Predictive modeling	421 students	Positive
Using Deep Learning to Optimize the Allocation of Rural Education Resources Under the Background of Rural Revitalization	Zhao	2025	China	Deep learning	Optimization algorithm using neural networks	Unknown	Positive
Research on Deep Learning Algorithm Application and Resource Allocation Optimization in Educational Resources Big Data Analysis	Liu	2025	n.a.	Deep learning	Backpropagation neural network	13 districts, unknown city	Positive
Teachers							
The Potential Impact of ChatGPT on Education: Using History as a Rearview Mirror	Wang & Guo	2023	China	Generative AI	Historical review	NA	Descriptive
Artificial Intelligence in Teaching and Teacher Professional Development: A Systematic Review	Tan et al.	2025	Various	Various	Systematic review	95 studies	Descriptive
Students' Perceptions and Applications of Metacognitive Awareness Levels in Problem Solving with ChatGPT	Filiz & Gür	2025	Turkey	ChatGPT	Mixed-methods	42 preservice teachers	Positive
Role of Artificial Intelligence in Enhancing Learning Outcomes of Pre-Service Social Studies Teachers	Al-Shammari & Al-Enezi	2024	Kuwait	Intelligent tutoring systems and smart content	Descriptive analysis	100 preservice teachers	Positive
Utilizing AI-Driven Virtual Training Platforms to Enhance Smart Board Skills Among English Language Teachers	Yousef et al.	2024	Iran & Turkey	AI-driven virtual training platform	Quasi-experimental design	Not provided	Positive
Improving Teaching at Scale: Can AI Be Incorporated Into Professional Development to Create Interactive, Personalized Learning for Teachers?	Copur-Gencturk et al.	2024	United States	AI-driven virtual training platform	Randomized controlled trial	52 math teachers	Positive

Title	Authors	Year	Location	Intervention	Methods	Size	Findings
Students							
Exploring the Impact of Artificial Intelligence in Advancing Smart Learning in Education: A Meta-Analysis with Statistical Evidence	Younas et al.	2025	Various	Various	Systematic review	46 studies	Positive
Analysing the Impact of Artificial Intelligence & Computational Sciences on Student Performance	García-Martínez et al.	2023	Various	Various	Systematic review	25 studies	Positive
The Impact of Generative AI Applications on Student Learning Outcomes in Science Education: A Systematic Review	Gunsaldi et al.	2025	United States & Turkey	Various	Systematic review	12 studies	Positive
Effective and Scalable Math Support: Experimental Evidence on the Impact of an AI- Math Tutor in Ghana	Henkel et al.	2024	Ghana	Rori	Quasi-experimental design	637 students	Positive
Generative AI Alone May Not Be Enough: Evaluating AI Support for Learning Mathematical Proof	Chen et al.	2025	United States	Proof-Review-AI-Tutor	Randomized controlled trial	308 students	Mixed
Improving Student Learning with Hybrid Human-AI Tutoring: A Three-Study Quasi-Experimental Investigation	Thomas et al.	2024	United States	Human–AI hybrid tutoring	Quasi-experimental design	950 students	Positive
Designing a Generative AI-Enabled Learning Environment for Mathematics Word Problem Solving in Primary Schools	Liu et al.	2025	China	ChatGPT-Mathematics Problem-Solving System	Quasi-experimental design	105 students	Positive
Tutor CoPilot: A Human-AI Approach for Scaling Real-Time Expertise	Wang et al.	2024	United States	Tutor CoPilot	Randomized controlled trial	~30,000 students	Positive
GPT-4 as a Homework Tutor Can Improve Student Engagement and Learning Outcomes	Vanzo et al.	2024	Italy	ChatGPT tutor	Randomized controlled trial	~70 students	Positive
AI Instructional Agent Improves Students' Perceived Learner Control and Learning Outcome: Empirical Evidence from a Randomized Controlled Trial	Qin et al.	2025	China	AI instructional agent	Randomized controlled trial	140 undergraduate students	Positive
The Impact of Artificial Intelligence Chatbots on Student Learning: A Quasi-Experimental Analysis of Learning Outcome and Engagement	Eteng-Uket & Ezeoguine	2025	Nigeria	AI chatbots	Quasi-experimental design	900 students	Positive
The Effect of Artificial Intelligence Applications in 6th Grade Visual Arts Course on Student Attitudes and Course Outcomes	Kara	2025	Turkey	AI chatbots	Quasi-experimental design	40 students	Positive

Title	Authors	Year	Location	Intervention	Methods	Size	Findings
The Impact of the Use of Artificial Intelligence-Based Gamification on the Development of the Motivation of Students of the Basic Stage Towards Education	Bani Ahmad	2024	Jordan	AI gamification	Quasi-experimental design	54 students	No difference
The Effectiveness of a Proposed Strategy for Teaching Geography Through Artificial Intelligence Applications in Developing Secondary School Students' Higher-Order Thinking Skills and Achievement	Almelweth	2022	Saudi Arabia	AI video content	Quasi-experimental design	60 students	Positive

n.a. = not applicable. NA = not available.

Ask An Expert:Understanding the Use of Artificial Intelligence to Support School Turnaround Strategies and the Effectiveness of Such Strategies

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Outline

- Purpose and framing
- How are states and districts using AI?
- What does the evidence say?
- Additional resources
- References
- Appendix. Summary of studies

Purpose and framing

What prompted this Ask an Expert?

> *"[SEA] wants to better understand how state education agencies (SEAs) and local education agencies (LEAs) have used artificial intelligence (AI) to support school turnaround."*
>
> October 2025

What is AI?

For purposes of this scan, AI refers to **computational systems that can perform complex tasks typically associated with human intelligence**, such as learning, reasoning, problem solving, perception, and decision making.

In education, AI refers to systems that apply algorithmic or machine learning techniques to adapt instruction, assess student learning in real time, tailor feedback, or support educators' decision making.

Sources: United Nations Educational, Scientific and Cultural Organization (n.d.); Simmons School of Education & Human Development (2025).

Common uses of AI in education

Adaptive instruction and tutoring systems

Personalized learning

Assessment

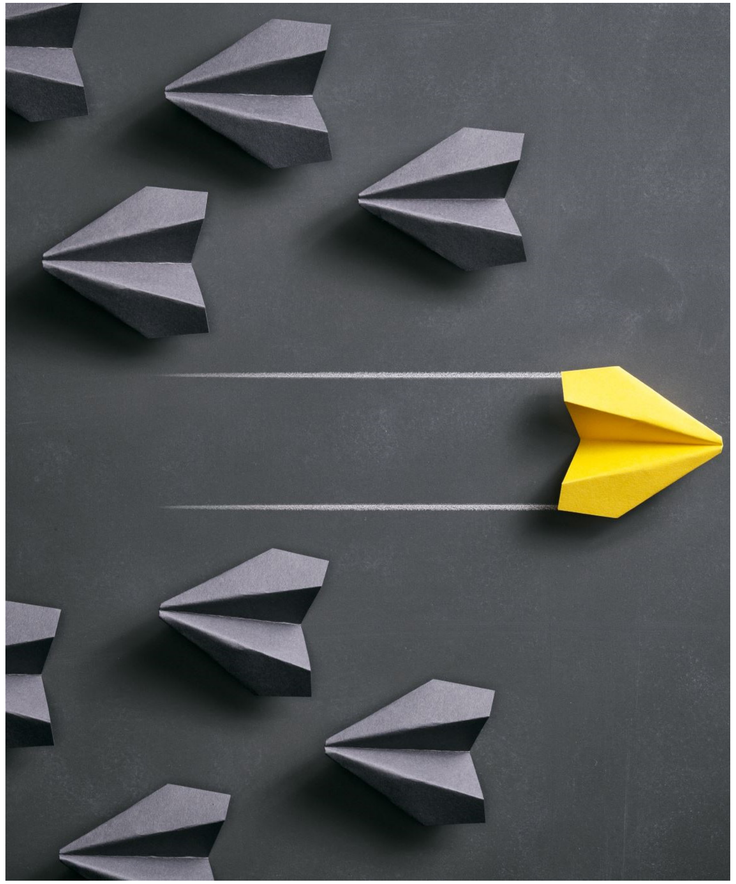
Early warning systems using predictive AI models

Logistical tasks

Source: Regional Education Laboratory Northwest (2025).

What is school turnaround?

- School turnaround strategies work to improve student outcomes:
  - By changing how schools and classrooms operate
  - Typically within three years



Source: What Works Clearinghouse (2008).

Research questions

1. How have SEAs, LEAs, and schools used AI to support school turnaround strategies, particularly as they relate to math tutoring, student supports, and instructional practices?

2. To what extent have AI-supported school turnaround strategies influenced school, teacher. and student outcomes (such as resource optimization, teacher knowledge and behaviors and student achievement and growth)?

How are SEAs, LEAs, and schools using AI?

How have SEAs, LEAs, and schools used AI to support school turnaround strategies, particularly as they relate to math tutoring, student supports, and instructional practices?

SEAs, LEAs, and schools use AI for predictive modeling of student outcomes, tutoring, and curriculum & professional development tools

1. Predictive modeling of student outcomes
2. Tutoring
3. Curriculum and professional development tools

States	SEAs	LEAs	Schools
Kentucky	X	X	
New Mexico		X	
Texas		X	X
Iowa	X		X
Texas		X	
Arizona	X	X	
New Jersey		X	
Indiana	X		X
Connecticut	X	X	X
Massachusetts	X	X	X

SEAs, LEAs, and schools in three states have used AI models to predict student outcomes

The Kentucky Board of Education provides three measurement and data visualization tools for free to districts: Early Warning System, Insights, and Persistence to Graduation.

Four districts in New Mexico—Farmington Municipal Schools, Raton Public Schools, the Carlsbad Municipal School District, and Hobbs Municipal Schools—are piloting an text-messaging AI tool by Edia to address chronic absenteeism.

Texas A&M University created a machine learning software, the District School Performance Predictor, to predict student STAAR test scores. LEAs and schools work with Texas A&M to review student data and identify areas for student improvement.

STAAR is State of Texas Assessments of Academic Readiness.
Sources: Texas A&M University Department of Educational Psychology (n.d.); Kentucky Department of Education (n.d.); New Mexico Public Education Department (2024).

SEAs, LEAs, and schools in five states have used intelligent tutoring systems

Amira is a digital reading tutor AI platform

- Iowa Department of Education provided Amira to Iowa schools.
- Aldine School District in Texas is implementing Amira to aid bilingual students and K-3 learners.

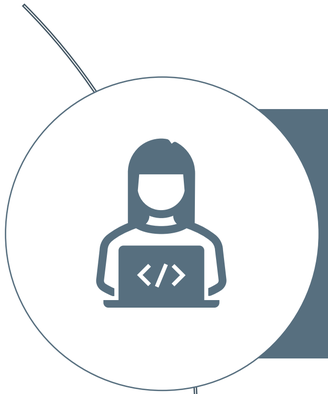
Khanmigo is a digital math and science tutor AI platform

- Arizona Department of Education is providing Khanmigo to 40 districts.
- Newark Public Schools piloted Khanmigo.

Indiana Department of Education awarded grants to 112 schools to pilot their choice of AI platforms for high-dosage tutoring.

Sources: Iowa Department of Education (2024); Chaviano (2025); Arizona Department of Education (2024); Gómez (2024a); Indiana Department of Education (2024).

SEAs in two states are piloting AI-enabled curricula and professional development tools



Connecticut State Department of Education launched two AI initiatives in 2025:

1. The K–12 Digital Citizenship Curriculum
2. The AI Pilot Program

Massachusetts Executive Office of Education launched two AI pilots in 2025:

1. The Future Ready: AI in the Classroom
2. AI curriculum pilot

Sources: Healey-Driscoll Administration (2024); Massachusetts Executive Office of Education (2024); Connecticut State Department of Education (2024).

What does the evidence say?

To what extent have AI-supported school turnaround strategies influenced school, teacher. and student outcomes (such as resource optimization, teacher knowledge and behaviors and student achievement and growth)?

Districts, schools, teachers, and students have seen benefits from integrating AI into their work

Districts and schools

We found **6** studies where districts or schools used machine learning or deep learning algorithms as predictive models or to optimize resource allocations.

Teachers

6 studies also included teachers using ChatGPT and other AI systems for their instructional practice and professional development.

Students

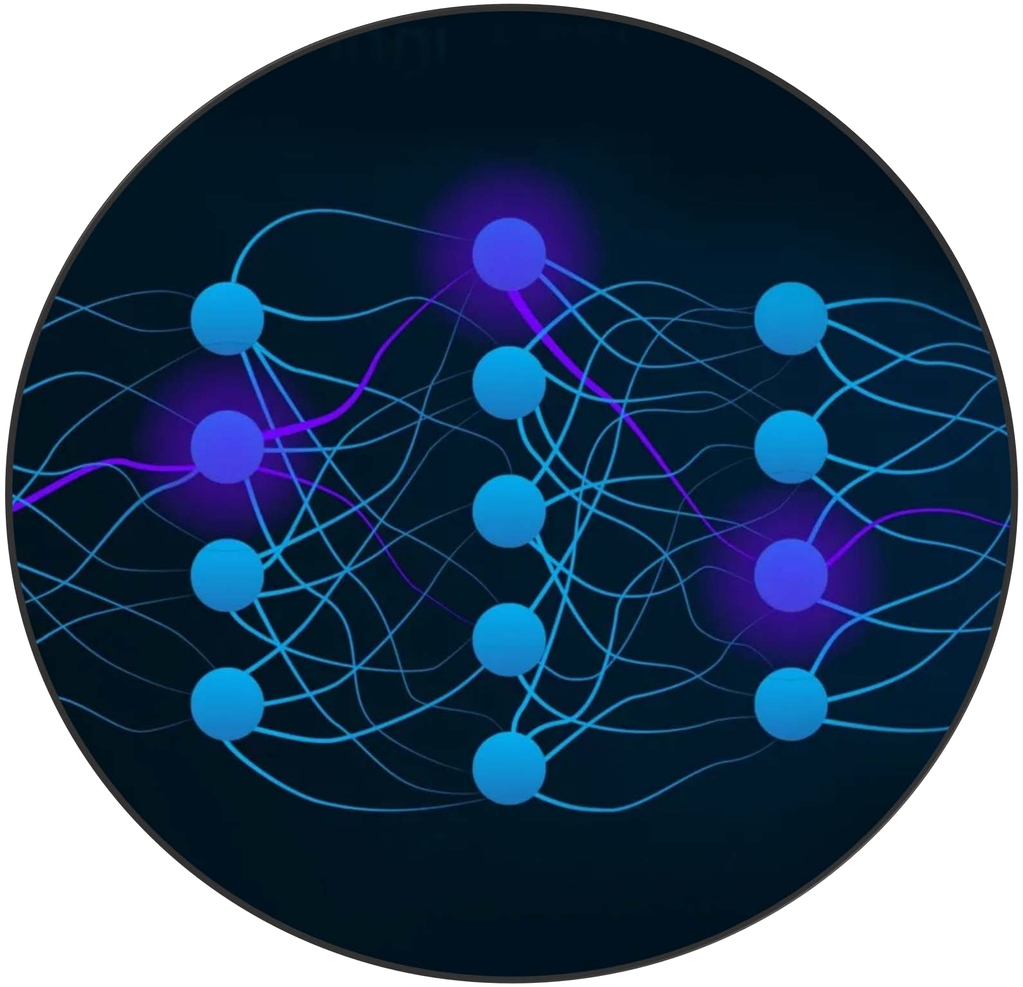
AI-driven tutoring models were tested in **4** studies specifically for math and **3** studies in non-math classes. **4** studies looked at other uses of AI in the classroom.

Districts and schools

Deep learning models can help schools and districts allocate resources more effectively and accurately predict student success, although machine learning algorithms perform on par with traditional early warning systems.

Deep learning models can shed light on more effective ways to allocate resources or staff

- Deep learning models outperform traditional (non-AI) methods for optimizing how schools allocate resources, staff, and materials.
- These models can either show how to allocate resources or evaluate the fairness or efficiency of allocations.



Sources: Zhao (2025); Liu (2025).

Deep learning models can predict student success and near-term academic risk accurately, but machine learning algorithms may not enhance traditional early warning systems

Predicting student success

- Two studies in Turkey
- Both studies found deep learning neural networks could predict students' course or assessment scores

Early warning systems

- Two studies in the U.S.
- Machine learning algorithms can predict near-term academic risks
- May not be more efficient than traditional models

Sources: Predicting student success: Kapucu et al. (2024) and Yildiz & Börekçi (2020); Early warning systems: Cattell & Bruch (2021); Bruch et al. (2020).

Teachers

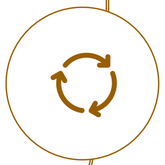
Although teachers value and use AI, strong evidence of its impact on student learning is lacking, though emerging research suggests AI-driven professional development can support better instruction.

How do teachers use AI?

Generate lesson content

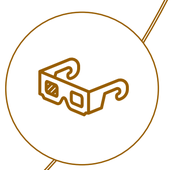
Develop assessments

Differentiate instructional strategies



Provide feedback to students or analyze behavior

Recommend resources



Offer augmented or virtual reality experiences

Sources: Wang & Guo (2023); Tan et al. (2025).

AI-driven virtual training platforms may support effective professional development

- English language teachers used AI-driven professional development to enhance Smart Board Skills
  - More likely to master and apply the content
- Math teachers used intelligent tutoring systems that provided just-in-time feedback to enhance math content and pedagogical knowledge
  - More likely to select cognitively demanding math tasks and provide more coherent instruction

Sources: Yousef et al. (2024); Copur-Gencturk et al. (2024).

Students are using AI in a variety of ways, and tools such as intelligent tutoring systems, AI-driven instruction, and smart content creation show promise for boosting achievement and engagement.

How do students use AI?

- Searching for information
- Finding answers
- Asking for feedback
- Receiving tutoring
- Monitoring their progress
- Personalizing their learning

Sources: Debets et al. (2025); Satir & Korucu (2023); Wang & Guo (2023); Alkan (2024).

AI tools that provide personalized and interactive learning support have moderate effects on student learning outcomes

- Three literature reviews including 82 unique, causal studies
- Reviewed a variety of uses:
  - AI tutors
  - Chatbots
  - Intelligent support for collaborative learning
  - Virtual reality modeling and labs
  - Flipped and gamified courses
  - Augmented reality
- Results:
  - Positive effects on student learning
  - Students felt they played an active role in learning
  - Increased engagement
  - Development of cognitive and critical thinking
  - Improved learning processes and reduced cognitive load

Sources: Younas et al. (2025); Garcia-Martinez et al. (2023); Gunsaldi et al. (2025).

Intelligent tutoring systems for math classes lead to more engagement and improved learning, but assessment gains are inconsistent

- Four studies in China, Ghana, or the United States using a QED or RCT
- Reviewed a variety of tutors:
  - Rori: an AI-powered tutor on WhatsApp
  - Proof-Review-AI-Tutor: an LLM tutor
  - AI-assisted math software (IXL, i-Ready, and MATHia's Live-Lab) and human-AI hybrid tutoring
  - ChatGPT-supported Mathematics Problem-Solving System
- Results:
  - Students answered more questions correctly
  - Higher homework grades
  - More time practicing and improved proficiency
  - More engagement
  - No discernible differences on end-of-course exam scores

Sources: Henkel et al. (2025); Chen et al. (2025); Thomas et al. (2023); Liu et al. (2025).

AI-driven tutoring systems in non-math lead to similar effects

- Three studies in Italy, Nigeria, or Turkey using a QED or RCT
- Reviewed a variety of chatbot tutors, such as ChatGPT or CoPilot
- Results:
  - Improved grammar, particularly from students with lower assessment scores
  - Higher engagement, enjoyment, and satisfaction
  - Improved learning
  - No discernible differences on end-of-course exam scores

Sources: Vanzo et al. (2024); Eteng-Uket & Ezeoguine (2025); Kara (2025).

Using Tutor CoPilot or AI to deliver lessons or create videos lead to positive outcomes, but gamified applications may not

- Reviewed:
  - Tutor CoPilot (a real-time assistant for tutoring)
  - An AI instructional agent capable of delivering lessons and responding to questions
  - Students using AI to create videos
- Results:
  - Students tutored with Tutor CoPilot were more likely to pass exit tickets, especially with less-experienced tutors
  - Students taught by the AI instructional agent felt they had more control and engaged more
  - Students using AI to help create educational videos did, however, show greater gains in achievement
- There were no notable differences in learning or motivation between students using Class Dojo, an AI-gamified application, and students taking a traditional science course

Sources: Wang et al. (2024); Qin et al. (2025); Bani Ahmad (2024); Almelweth (2022).

What does this all mean?

AI has been used in a variety of ways to ultimately improve instruction and support student learning and engagement

Districts and schools

AI models can help allocate resources more effectively and accurately predict student success, but some may not enhance early warning systems.

Teachers

Although research has not established which teacher uses of AI impact student learning, emerging research suggests AI-driven professional development can support better instruction.

Students

Tools such as intelligent tutoring systems, AI-driven instruction, and smart content creation show promise for boosting achievement and engagement.

AI models can help allocate resources more effectively and accurately predict student success but may not enhance early warning systems

Predictive modeling

It is possible to use predictive models (regressions or LLMs) to identify schools that need support and the areas they need support in.

GenAI

A use case of generative AI would be to process unstructured text (such as school board transcripts or notes) to include in predictive models or to identify trends.

Deep learning

It is possible to use deep learning models to assess fair resource allocation and teaching quality.

Although research has not established which teacher uses of AI impact student learning, emerging research suggests AI-driven professional development can support better instruction

Teachers can use AI to generate personalized content, analyze learning behavior, support instructional design, or recommend resources.

Implementing AI into professional development offerings has been shown to lead to positive teacher outcomes.

Tools such as intelligent tutoring systems, AI-driven instruction, and smart content creation show promise for boosting achievement and engagement

- Intelligent tutoring systems or other AI-driven learning supports can have an impact on students' learning and engagement, including:
  - Rori
  - ChatGPT-supported Mathematics Problem-Solving System
  - Human–AI hybrid tutoring
- Tutors using Tutor CoPilot to support their instruction have demonstrated a positive impact on students' exams and engagement

Additional resources

What else exists?

- Student Achievement Partners' Guide to Integrating Generative AI for Deeper Math Learning summarizes specialized AI tools for math.
- The Learning Agency's Automated Student Assessment Prize (ASAP) 2.0 evaluates LLMs on their ability to score student-written essays, a crucial capability for supporting educators and providing timely feedback to students.
- Edtech Insiders' Gen AI Use Cases in K-12 education is a market map that features specific use cases for AI instructional materials; assessment and feedback; teacher practice support; teacher professional development; student support; and social tools.
- The Stanford AI Hub for Education's Research Study Repository synthesizes descriptive research and impact evaluations of AI use cases in education.
- CRPE's AI Early Adopter Database tracks districts at the forefront of AI adoption and how they're using and piloting AI, the challenges they face, and what others can learn.

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Appendix. Summary of studies

Districts and schools	Authors	Year	Location	Intervention	Methods	Size	Findings
Identifying Students At Risk Using Prior Performance Versus a Machine Learning Algorithm	Cattell & Bruch	2021	United States	Machine learning algorithm	Predictive modeling	~24,000 students	No difference
Using Data from Schools and Child Welfare Agencies to Predict Near-Term Academic Risks	Bruch et al.	2020	United States	Machine learning algorithm	Predictive modeling	~30,000 students	Positive
Predicting Secondary School Students' Academic Performance in Science Course by Machine Learning	Kapucu et al.	2024	Turkey	Deep learning	Neural networks	445 students	Positive
Predicting Academic Achievement with Machine Learning Algorithms	Yildiz & Börekçi	2020	Turkey	Machine learning algorithm	Predictive modeling	421 students	Positive
Using Deep Learning to Optimize the Allocation of Rural Education Resources Under the Background of Rural Revitalization	Zhao	2025	China	Deep learning	Optimization algorithm using neural networks	Unknown	Positive
Research on Deep Learning Algorithm Application and Resource Allocation Optimization in Educational Resources Big Data Analysis	Liu	2025	n.a	Deep learning	Backpropagation neural network	13 districts, unknown city	Positive

n.a. = not applicable

Teachers	Authors	Year	Location	Intervention	Methods	Size	Findings
The Potential Impact of ChatGPT on Education: Using History as a Rearview Mirror	Wang & Guo	2023	China	Generative AI	Historical review	NA	Descriptive
Artificial Intelligence in Teaching and Teacher Professional Development: A Systematic Review	Tan et al.	2025	Various	Various	Systematic review	95 studies	Descriptive
Students' Perceptions and Applications of Metacognitive Awareness Levels in Problem Solving with ChatGPT	Filiz & Gür	2025	Turkey	ChatGPT	Mixed-methods	42 preservice teachers	Positive
Role of Artificial Intelligence in Enhancing Learning Outcomes of Pre-Service Social Studies Teachers	Al-Shammari & Al-Enezi	2024	Kuwait	Intelligent systems and smart content	Descriptive analysis	100 preservice teachers	Positive
Utilizing AI-Driven Virtual Training Platforms to Enhance Smart Board Skills Among English Language Teachers	Yousef et al.	2024	Iran & Turkey	AI-driven virtual training platform	Quasi-experimental design	Not provided	Positive
Improving Teaching at Scale: Can AI Be Incorporated Into Professional Development to Create Interactive, Personalized Learning for Teachers?	Copur-Gencturk et al.	2024	United States	AI-driven virtual training platform	Randomized controlled trial	52 math teachers	Positive

NA = not available

Students	Authors	Year	Location	Intervention	Methods	Size	Findings
Exploring the Impact of Artificial Intelligence in Advancing Smart Learning in Education: A Meta-Analysis with Statistical Evidence	Younas et al.	2025	Various	Various	Systematic review	46 studies	Positive
Analysing the Impact of Artificial Intelligence & Computational Sciences on Student Performance	Garcia-Martinez et al.	2023	Various	Various	Systematic review	25 studies	Positive
The Impact of Generative AI Applications on Student Learning Outcomes in Science Education: A Systematic Review	Gunsaldi et al.	2025	United States & Turkey	Various	Systematic review	12 studies	Positive
Effective and Scalable Math Support: Experimental Evidence on the Impact of an AI- Math Tutor in Ghana	Henkel et al.	2024	Ghana	Rori	Quasi-experimental design	637 students	Positive
Generative AI Alone May Not Be Enough: Evaluating AI Support for Learning Mathematical Proof	Chen et al.	2025	United States	Proof-Review-AI-Tutor	Randomized controlled trial	308 students	Mixed results
Improving Student Learning with Hybrid Human-AI Tutoring: A Three-Study Quasi-Experimental Investigation	Thomas et al.	2024	United States	Human-AI hybrid tutoring	Quasi-experimental design	950 students	Positive
Designing a Generative AI-Enabled Learning Environment for Mathematics Word Problem Solving in Primary Schools	Liu et al.	2025	China	ChatGPT-Mathematics Problem-Solving System	Quasi-experimental design	105 students	Positive

Title	Authors	Year	Location	Intervention	Methods	Size	Findings
Tutor CoPilot: A Human-AI Approach for Scaling Real-Time Expertise	Wang et al.	2024	United States	Tutor CoPilot	Randomized controlled trial	~30,000 students	Positive
GPT-4 as a Homework Tutor Can Improve Student Engagement and Learning Outcomes	Vanzo et al.	2024	Italy	ChatGPT Tutor	Randomized controlled trial	~70 students	Positive
AI Instructional Agent Improves Students' Perceived Learner Control and Learning Outcome: Empirical Evidence from an RCT	Qin et al.	2025	China	AI instructional agent	Randomized controlled trial	140 undergrad students	Positive
The Impact of AI Chatbots on Student Learning: A Quasi-Experimental Analysis of Learning Outcome and Engagement	Eteng-Uket & Ezeoguine	2025	Nigeria	AI chatbots	Quasi-experimental design	900 students	No difference
The Effect of Artificial Intelligence Applications in 6th Grade Visual Arts Course on Student Attitudes and Course Outcomes	Kara	2025	Turkey	AI chatbots	Quasi-experimental design	40 students	Positive
The Impact of the Use of AI-Based Gamification on the Development of the Motivation of Students of the Basic Stage Towards Education	Bani Ahmad	2024	Jordan	AI gamification	Quasi-experimental design	54 students	No difference
The Effectiveness of a Proposed Strategy for Teaching Geography Through AI Applications in Developing Secondary School Students' Higher-Order Thinking Skills and Achievement	Almelweth	2022	Saudi Arabia	AI video content	Quasi-experimental design	60 students	Positive

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