Using AI to Strengthen STEM with CRSE Competencies

Sarah Anne Eckert, PhD & Beth Rajan Sockman, PhD

PA Teacher Education CRSE Initiative

Artificial intelligence can assist educators to align their STEM curriculum with the CRSE competencies by serving as a kind of curricular mirror for STEM teachers. Even the most reflective educator carries blind spots shaped by training, textbooks, and time constraints. AI can help audit whose voices are centered, identify patterns in representation, suggest culturally grounded problem contexts, translate materials to honor linguistic diversity, and generate multiple entry points into complex concepts without lowering cognitive demand. In mathematics and science, where tasks often appear context-neutral, AI can help surface real-world applications that connect to students' communities, economies, and lived experiences. Used thoughtfully, AI does not replace teacher judgment; it expands it. It reduces the invisible labor of redesign so that teachers can focus on relationships, discourse, and intellectual rigor. In this way, AI becomes not a shortcut, but a scaffold for equity, helping educators design STEM learning environments where belonging and brilliance grow together.

When using AI, treat it as a draft partner, not a final authority. Always verify information for accuracy, cross-check claims with trusted scholarly or disciplinary sources, and confirm alignment with current standards and research.

Domain 1 & Competency 4

Strategy: Student-Informed Planning

Deploy LLMs as Contextual Translators to bridge the gap between STEM standards and student lived experiences. By synthesizing anonymized interest data with core curriculum requirements, the AI generates hyper-relevant anchoring events, localized community issues, and tailored assessment strategies—transforming abstract standards into culturally responsive, high-engagement units.

Prompt 1	Prompt 2	Prompt 3
The "Community Context" Prompt *Goal*: Bridges the gap between STEM standards and students' actual lives (Student-Informed Planning). *Prompt:* "I am teaching a unit on [Insert Topic, e.g., Linear Equations] for [Insert Grade Level]. My students are highly interested in [Insert Interests, e.g., sneaker culture, soccer, local urban gardening]. Act as a culturally responsive instructional designer. Generate three real-world scenarios or data sets that use these interests to teach the core concepts of this unit. Ensure the scenarios avoid stereotypes and position the students as 'experts' or 'problem solvers' in their own communities."	**Prompting for Synthesis:** *Goal:* To systematically map STEM standards to student sub-cultures using AI, generating hyper-relevant Phenomenon-Based Learning hooks that bridge the engagement gap *Prompt*: "Act as an expert STEM Instructional Designer and Contextual Translator for [Insert Grade Level]. My students are highly interested in [Insert Interests, e.g., Skateboarding, Hip-Hop, local landmarks]. I need to teach the core standard of [Insert Target Standard, e.g., Newton's Laws]. Generate three distinct anchoring phenomena that bridge this standard with my students' interests. For each phenomenon, provide: 1. The Hook: A 2-3 sentence narrative describing an observable, puzzling event. 2. The Driving Question: A student-facing inquiry that sparks curiosity. 3. The Standard Alignment: A brief explanation of how this specific event maps to the core science concepts. Ensure the scenarios avoid 'corny' or forced connections and instead position the students as 'experts' or 'investigators' in their own culture."	**Hyper-Local Data Generation:** *Goal*: To replace generic textbooks with Hyper-Local Data Simulations, using AI to bridge abstract statistical concepts with immediate, community-specific issues (e.g., local water quality, traffic, or energy use). *Prompt:* "I am teaching a unit on [Insert Topic, e.g., Environmental Science] for [Insert Grade Level]. My school is located in [Insert Zip Code/Neighborhood] where the community is currently facing issues with [Insert Local Issue, e.g., traffic congestion, water quality, or heat islands]. Act as a Data Scientist and Curriculum Designer. Generate a simulated, statistically plausible dataset of 30-50 points that reflects this local issue. Provide a brief narrative explaining the context of this data and three inquiry-based questions that require students to use the data to propose a community-level solution. Ensure the data is realistic to our specific geography and positions students as 'community analysts' rather than passive observers."

Strategy: Knowledge Production & Diverse Representation

Use AI as a Curriculum Researcher to decenter the "Western Canon" by identifying and integrating global indigenous innovations, non-Western scientific breakthroughs, and diverse historical perspectives into standard STEM units.

Prompt 1	Prompt 2
The "Hidden Figures" Researcher *Goal*: Centers diverse experts to move beyond the traditional Western canon (Diverse Representation). *Prompt:* "I am planning a lesson on [Insert Scientific Law or Math Concept]. Currently, my curriculum only mentions European or male scientists. Please identify 3–4 experts from historically marginalized communities (specifically looking for [Race/Gender/Geography]) who have made significant contributions to this specific field. For each, provide: 1) Their name and background, 2) Their specific contribution to this concept, and 3) A brief 'primary source' hook or quote that highlights their brilliance for a student-led discussion."	**The Big Story** *Goal:* Open up the brilliant conceptualization (Primary Source Adaptation). *Prompt: "*Simplify the language of a complex primary source or scientific paper written by a diverse scholar so it is accessible for middle or high school reading levels without losing the "brilliance" of the original."

Strategy: Anticipatory Planning for Barriers

Use AI as a Universal Design for Learning (UDL) Consultant to preemptively identify instructional "friction points" within a lesson plan and generate tiered scaffolding options that ensure accessibility for diverse learners without lowering academic rigor.

AI Prompt: The "Barrier Breaker" Scaffold Generator

Goal: Identifies cultural/linguistic assumptions and builds supports (Anticipatory Planning).

Prompt: "Review the following word problem/lesson description: [Paste Text Here]. First, identify any 'hidden' cultural assumptions, idiomatic language, or specific prior knowledge that might exclude an English Language Learner or a student from a diverse background. Second, generate a 'Scaffold Kit' for this problem, including: 1) A 5-word glossary with student-friendly definitions, 2) Three sentence stems for scientific reasoning (e.g., 'I noticed... because...'), and 3) A version of the problem that uses a more globally universal context."

Strategy: Multiple Entry Points & Flexible Pathways

The AI Leverage: Use AI as a Multi-Modal Content Creator by creating different representations of information and re-write problems into levels or tiers.

Prompt 1	Prompt 2	Prompt 3
The "Multi-Entry Point" Re-Writer *Goal:* Creates tiered access to the same high-rigor task (Multiple Entry Points). *Prompt:* "Act as a UDL (Universal Design for Learning) expert. I have a core math/science task: [Insert Task/Equation]. Please re-write this single task into four different entry points that maintain high DOK (Depth of Knowledge) rigor: 1. Visual/Graphic: Describe how to represent this as a diagram or flow chart. 2. Narrative: Describe the problem as a story-based scenario. 3. Numerical/Data: Provide a table of values that leads to the concept. 4. Symbolic: The formal mathematical/scientific notation. Ensure all four versions lead to the same learning objective."	**The "Flexible Assessment" Menu** *Goal*: Plans for varied demonstrations of understanding (Flexible Assessment). *Prompt:* "For my unit on [Insert Topic], I want to move beyond a standard multiple-choice quiz. Generate an 'Assessment Menu' based on Bloom's Taxonomy. Provide four options for students to demonstrate mastery: one Visual (e.g., annotated model), one Oral/Verbal (e.g., a podcast explanation), one Digital (e.g., a simulation or code), and one Written (e.g., a letter to a community leader). Each option must be mapped to the same grading rubric criteria."	**The Tiered Task Generation** *Goal:* Plans for varied demonstrations of understanding (Tiered Questions). *Prompt:* "Re-write this Calculus problem into three levels of 'Depth of Knowledge' (DOK): Level 1 (Recall/Calculation), Level 2 (Skill/Concept application), and Level 3 (Strategic Thinking/Modeling)." Each option needs to build on the understanding of the one before.

Doman 2 & Competency 5

Strategy: Normalize Multiple Ways of "Doing STEM"

The AI Leverage: Use AI as a Strategy Synthesizer to bridge the gap between "school math" and "street math," validating diverse cognitive approaches—such as mental estimation, indigenous counting systems, or artistic spatial reasoning—and formalizing them into standard-aligned scientific models.

AI Prompt: The "Logic Validator" Prompt

Goal: Validates student-generated methods and connects them to formal theory (Normalizing Thinking).

Prompt: "I have a student who solved the following problem: [Insert Problem] using this specific logic: [Describe Student's Approach]. While it's not the 'standard' textbook method, I want to validate their thinking. 1) Identify the underlying mathematical/scientific principles in their logic. 2) Provide a script for me to explain to the class how this student's 'home-grown' method is a valid intellectual asset in the field of STEM."

Strategy: Cultural and Historical Visibility in STEM

The AI Leverage: Use AI as a Biographical Archivist to resurface the "hidden figures" of STEM, connecting specific lesson standards to the lived experiences and contributions of diverse scientists who have been historically marginalized or erased.

The AI Leverage: Use AI as a Strategy Synthesizer to bridge the gap between "school math" and "street math," validating diverse cognitive approaches—such as mental estimation, indigenous counting systems, or artistic spatial reasoning—and formalizing them into standard-aligned scientific models.

AI Prompt: The "Non-Western Methods" Integration

Goal: Centers diverse contributions as core content (Visible Accessibility).

Prompt: "I am teaching a lesson on [Insert Topic, e.g., Geometry/Symmetry]. Instead of using only Greek or European examples, provide an example of how this concept was utilized in [Insert Region/Culture, e.g., West African textiles or Islamic architecture]. Explain the mathematical complexity of their method so I can teach it as a primary way of understanding the concept, not just a 'fun fact' on the side."

Strategy: Language as an Intellectual Asset

The AI Leverage: Use AI as a Translinguistic Bridge to validate multilingualism as a cognitive superpower, allowing students to leverage their home languages to conceptualize complex STEM ideas before "translating" them into formal academic English.

AI Prompt: The "Translanguaging" Scaffold

Goal: Values home language as a tool for cognition (Language as an Asset).

Prompt: "Create a 'Translanguaging Bridge' for a unit on [Insert Topic]. Generate a table for students. Column 1: Academic STEM term. Column 2: Simplified English definition. Column 3: Space for 'Home Language or Community Slang.' Column 4: A bridge sentence that connects the informal term to the formal one. For example: 'When I say [Community Term], I am describing the process of [Academic Term].'"

Domain 2 & Competency 8

Strategy: Warm Demand Pedagogy

The AI Leverage: Use AI as a Scaffold Architect to practice "Warm Demander" pedagogy—maintaining high-expectations and DOK 3 rigor while providing just-in-time, invisible supports that prevent student frustration without lowering the cognitive floor.

AI Prompt: The "DOK Leveler" Prompt

Goal: Ensures the teacher is pushing students toward DOK 3/4 (Strategic/Extended Thinking).

Prompt: "I am teaching [Insert STEM Topic]. Currently, my lesson is at a DOK 1 level (Recall). Please provide three ways to elevate this task to DOK 3 (Strategic Thinking) or DOK 4 (Extended Thinking). For the DOK 3 version, provide a 'Warm Demander' script I can use to support a student who feels overwhelmed by the complexity without lowering the rigor."

Strategy: Transparent Success Criteria

The AI Leverage: Use AI as an Exemplar Generator to demystify academic expectations, producing a range of high-, mid-, and low-level models across Bloom's levels so students can visualize the "climb" toward mastery and self-assess their progress.

AI Prompt: The "Bloom's Exemplar" Menu

Goal: Makes success criteria transparent through concrete examples (Transparent Success).

Prompt: "For my unit on [Insert Topic], I need three student exemplars for a final project. Generate:

1. The 'Proficient' Exemplar: Meets the basic requirements of Bloom's 'Apply' level.
2. The 'Expert' Exemplar: Demonstrates Bloom's 'Evaluate' level by critiquing a model.
3. The 'Innovator' Exemplar: Reaches Bloom's 'Create' level by proposing a new solution. List the specific characteristics that distinguish each level so I can share them with my students."

Strategy: Public Belief in Student Brilliance

The AI Leverage: Use AI as an Identity Coach to shift the classroom narrative toward "Public Belief in Student Brilliance," using personalized feedback loops that explicitly name and celebrate the specific intellectual strengths, creative leaps, and mathematical "power moves" observed in student work.

AI Prompt: The "Industry Mirror" Prompt

Goal: Positions students as emerging experts (Student Brilliance).

Prompt: "Act as a STEM Career Coach. I am going to provide a student's explanation of a concept: [Insert Student Quote]. 1) Identify the sophisticated STEM principle they are intuitively describing. 2) Provide a short 'Validation Script' for me to say to the student that connects their wording to a specific career (e.g., 'You are thinking like a Civil Engineer because...')."

Domain 3 & Competency 3

Strategy: Community-Connected Problem Solving

The AI Leverage: Use AI as an Environmental Data Aggregator to synthesize hyper-local datasets—such as air quality, urban heat maps, or watershed health—transforming abstract ecological standards into actionable, community-specific investigations.

Prompt 1	Prompt 2	Prompt 3
The "Neighborhood Scientist" Prompt Goal: Connects abstract standards to local real-world issues (DOK 4). Prompt "I am teaching [Grade/Subject]. My school is located in [City/Neighborhood]. Identify a local environmental or social issue (like air quality, transit, or food access) that can be modeled using [Specific Math/Science Standard]. Provide a week-long 'Inquiry Blueprint' where students collect data, analyze it, and propose a solution to a local community leader."	**Hyper-Local Contextualizing** *Goal:* To elevate student inquiry from rote calculation to DOK 4 Extended Thinking by using AI to synthesize real-time neighborhood data into complex, multi-dimensional community design challenges. *Prompt:* "Act as a Senior Urban Planner and STEM Curriculum Expert for [Insert Grade Level]. My school is located in [Insert Zip Code/Neighborhood] and we are studying [Insert Topic, e.g., Environmental Science or Geometry]. Use your ability to access or simulate real-time and historical data for this specific area—such as EPA air quality indices, city transit maps, or local land-use patterns—to design one DOK 4 Extended Thinking project. The project must require students to synthesize this local data to solve a complex, open-ended problem (e.g., redesigning a local transit intersection for better air flow or mapping the correlation between local heat islands and public park access). Provide a project rubric, a list of the specific local data points students will need to analyze, and a 'Community Impact' reflection prompt. Position the students as lead consultants tasked with presenting their findings to a local city council."	**Problem Simulation** *Goal:* To transition students from procedural calculation to Bloom's: Evaluate by using AI to simulate the social and ethical consequences of mathematical optimizations, forcing a critical analysis of who "wins" and "wins" loses in technical solutions. *Prompt:* "I am teaching a unit on [Insert Math/Science Topic, e.g., Ratio and Proportion or Graph Theory] for [Insert Grade Level]. My students have developed a technical solution for [Insert Problem, e.g., optimizing local bus routes or placement of new park benches]. Act as a Social Impact Auditor and Urban Planner. Analyze our mathematical solution through the lens of equity and access for the neighborhood of [Insert Zip Code/City]. Simulate three potential 'unintended consequences' of our optimization—for example, identify specific demographics or sub-neighborhoods that might lose service or access based on these calculations. Provide a 'Critical Challenge' prompt that asks students to justify their mathematical choices against these social impacts or to propose a 'Weighted Solution' that prioritizes equity over raw efficiency."

Strategy: Student-Generated Contexts

The AI Leverage: Use AI as a Context Formalizer to instantly transform raw, informal student interests—such as slang, gaming mechanics, or social media trends—into rigorous, standard-aligned academic problems that maintain the student's original "voice" while meeting STEM requirements.

Prompt 1	Prompt 2	Prompt 3
The "Student-to-Scholar" Problem Creator *Goal:* Positions students as knowledge creators (Bloom's: Create). *Prompt:* "I have a student who is an expert in [Student Interest, e.g., hair braiding/Minecraft/cooking]. Help this student write a 'Challenge Problem' for their classmates that uses the logic of [STEM Concept, e.g., tessellations/ratios/resource management]. The problem should be high-rigor (DOK 2 or 3) but entirely based on the student's personal expertise.	**Scaffolded Authorship** *Goal:* To achieve Bloom's: Create by using AI as a Pedagogical Co-Author, empowering students to formalize their personal lived experiences into rigorous, standardized STEM tasks that validate their cultural expertise. *Prompt:* Students provide a "story" or a life experience to the AI (e.g., "Helping my grandma cook for 20 people"). The AI then helps the student "code-switch" that story into a formal STEM task, complete with variables and constraints, positioning them at Bloom's: Create.	**The Problem-Bank Generator** *The Goal:* To foster Multiperspective Synthesis by using AI as a Stakeholder Persona Engine, requiring students to evaluate their STEM solutions through competing professional and community lenses to ensure holistic viability. *Prompt*: "Act as a Narrative Game Designer and Math Lead for [Insert Grade Level]. My students are interested in [Insert Interests, e.g., sneakers, gaming, or competitive sports]. Using the core concepts of [Insert Math Topic, e.g., Linear Inequalities or Statistics], generate a 'Problem Bank' of five word problems. In these problems, the students must be the protagonists (e.g., 'You are a sneaker designer trying to calculate...') rather than passive observers. For each problem, include: 1. The Scenario: A high-interest situation based on the interests provided. 2. The Challenge: A rigorous mathematical obstacle that must be solved to 'win' the scenario. 3. The Extension: A 'What If' question that changes a variable, requiring deeper analysis. Ensure the tone is authentic to the hobby and positions mathematical proficiency as the 'superpower' needed to succeed in that field."

Strategy: Collaborative Sense-Making

The AI Leverage: Use AI as a Socratic Facilitator to guide students through the inquiry process by providing adaptive, question-based scaffolding that challenges their assumptions and deepens their understanding of core STEM concepts without giving away the final answer.

Prompt 1	Prompt 2
Discussion Starters *Goal:* To move beyond rote memorization into DOK 3 Strategic Thinking by using AI to generate "Controversy Cards"—open-ended, STEM-based provocations that require students to justify their reasoning and debate complex, non-binary solutions. *The Prompt:* "Act as a Socratic Facilitator and STEM Ethics Expert for [Insert Grade Level]. We are currently studying [Insert Topic, e.g., Genetic Engineering or Renewable Energy Infrastructure]. Generate five 'Controversy Cards' designed to spark a structured classroom debate. Each card must present a scenario with no single 'correct' answer, forcing students to weigh scientific evidence against ethical or community impact. For each card, provide: 1. The Dilemma: A 2-sentence 'tough choice' scenario. 2. The Conflict: Two competing, valid scientific or social perspectives. 3. The Inquiry: A DOK 3 question that requires students to cite specific STEM concepts from this unit to defend their position. Ensure the scenarios are provocative but age-appropriate, positioning students as 'Ethical Review Boards' for their own community."	**Perspective Simulation** *Goal:* To foster Multiperspective Synthesis by using AI as a Perspective Engine, requiring students to evaluate their STEM solutions through competing professional and community lenses to ensure holistic viability. *Prompt:* During group work, students can ask an AI: "Give us three different perspectives a city planner, a local resident, and an environmentalist might have on this data." This forces collective "perspective-taking" and respectful challenge.

Strategy: Critical STEM Inquiry

The AI Leverage: Use AI as a Bias Auditor to scrutinize STEM datasets, historical case studies, or urban planning models—such as redlining's impact on local tree canopy or biased facial recognition algorithms—empowering students to identify systemic inequities through a mathematical and scientific lens.

Prompt 1	Prompt 2	Prompt 3
The "Ethical Inquiry" Prompt Goal: Facilitates critical thinking about the impact of STEM (Bloom's: Evaluate). "Provide a 'Critical Inquiry' lesson extension for a unit on [Topic, e.g., Data Statistics/Genetics]. Generate four discussion questions that ask students to Evaluate the social impact of this technology. Specifically, ask: 1) Who benefits from this? 2) Who is potentially harmed? 3) How could the data be biased? 4) What is a more equitable way to use this STEM knowledge?"	**Algorithmic Bias Labs** *Goal:* To achieve DOK 4 Synthesis by using AI as a Sociotechnical Auditor, empowering students to deconstruct the mathematical architecture of bias in "black box" algorithms and propose equitable redesigns. *Prompt:* Have students use AI to analyze how data sets (like facial recognition or health algorithms) can be biased. This hits DOK 4 by requiring students to synthesize STEM knowledge with social justice.	**Historical Inquiry** *Goal:* To transform students into Scientific Historians by using AI to audit the methodology of landmark studies, identifying the specific demographic or environmental exclusions that shaped modern STEM biases. *Prompt:* "Who was excluded from the data collection in this famous scientific study?"

Domain 4 & Competency 9

Strategy: The "Hidden Curriculum" Identity Audit

The AI Leverage: Use AI as an Equity Auditor to uncover the "Hidden Curriculum"—the unwritten rules, cultural assumptions, or biased imagery embedded in STEM materials—ensuring that instructional content doesn't inadvertently alienate students through exclusionary contexts.

AI Prompt: The "Equity Audit" Scanner

Goal: Identifies "hidden curriculum" biases in instructional materials.

Prompt: "Act as an Equity and Inclusion Consultant. I am going to provide a set of math/science word problems: [Insert Problems]. Please analyze them for: 1) Heteronormative or traditional family assumptions, 2) Socioeconomic assumptions (e.g., assuming every kid has a backyard or expensive tech), and 3) Eurocentric naming conventions. Provide a revised version of each problem that is more inclusive and affirms diverse identities."

Strategy: Strategy: Active Disruption & The ACTION Framework

The AI Leverage: Use AI as a Communication Coach to operationalize the ACTION framework (Ask, Choose, Tell, Identify, Options, Next steps), allowing teachers and students to rehearse and refine the language needed to actively disrupt microaggressions or biased statements in real-time.

AI Prompt: The "ACTION" Framework Rehearsal

Goal: Practices disrupting microaggressions in real-time.

Prompt: "I want to practice disrupting microaggressions in my STEM classroom. Act as a coach. I will describe a situation where a bias was expressed. You will walk me through each step of ACTION or Micro-Intervention Model asking me what I would say for that step, and then giving me feedback on how to make my response more restorative and clear."

Strategy: Professional Development & Feedback

Use AI as a Curator of Diverse Perspectives to simulate "The Critical Friends Circle"—providing teachers with immediate, varied feedback on their lesson plans from the perspectives of diverse educational experts (e.g., a neurodiversity advocate, an English Language Learner specialist, and a trauma-informed practitioner).

AI Prompt: The "STEM Identity" Newsletter Generator

Goal: Bridges home and school while highlighting diverse brilliance.

Prompt: "Create a template for a monthly 'STEM Identity' newsletter for families. Include: 1) A 'Community Spotlight' section where parents can share how they use logic/math at work, 2) A 'Historical Hero' section featuring a scientist from a marginalized background relevant to our current unit on [Topic], and 3) A 'Home Inquiry' tip that uses common household items so it is accessible to all families regardless of income."