Re: Examples of what NCADE might fund
Date. May 1, 2023

Congress has directed the Institute of Education Sciences (IES) to use a portion of its Research, Development, and Dissemination funds to support quick turnaround, high-reward scalable solutions intended to significantly improve outcomes for students. This investment enables the development of structures and approaches that move towards the creation of a 5th Center at IES: a National Center for Advanced Development in Education (NCADE). This new Center would be uniquely positioned to further research and development in innovative educational technology and programs. It would build on innovative development work already being done between IES and the National Science Foundation via the new AI Institute, which funded a project to advance artificial intelligence (AI) and create the technology to assist speech-language pathologists (SLPs) with identifying students in need of speech and language services and delivering individualized interventions

This memo outlines some specific examples of projects that NCADE might fund. The examples are focused on the development side of R&D, moving from foundational research and proofs-of-concept to actual prototype development and infrastructure that can scale. Like at other ARPAs, it would be the program managers in the pilot program that ultimately decide which projects to pursue.

Idea	**Automate tutoring for struggling students**
Objective	● Automate tutoring in order to expand access to 1:1 tutoring for low-income students ● Deliver motivational and academic support
Why It's Important	1:1 tutoring has been noted as an effective intervention to improve learning outcomes among students, but students from low-income backgrounds and low-bandwidth communities have significantly fewer opportunities for out-of-school tutoring services. Researchers at CU-Boulder and elsewhere have been experimenting with chatbots and the automating of tutoring given the success of ChatGPT. Expanding access to 1:1 tutoring will promote equitable learning outcomes.
What Would Be Funded	Development of the underlying infrastructure including datasets for a chatbot specialized in a specific, well-defined domain leveraging new models like ChatGPT
Examples of what this might look once implemented	For instance, students would use a chatbot as an after-school resource to supplement their in-school learning. It can be integrated in a messaging app such as Whatsapp. The chatbot would deliver questions or problems within a specific domain; responses will be based on rules-based engineering in which the chatbot can respond with: 1) the answer is correct, followed by an explanation of how the skill relates to a career path or aspiration; 2) the answer is incorrect, and the student is prompted to try again with motivational messaging, or 3) the student could use a worked example or other hint, along with metacognitive advice (such as "Take a break" or "Write down the steps to solve this problem").

Idea	**Create new teaching and learning models beyond one teacher to 35 students.**
Objective	• Introduce new, innovative models of instruction that offer more personalization and adaptivity to the diverse needs of students.
Why It's Important	There is wide recognition that American schooling could benefit from different models of instruction. A few models–such as project-based learning–have succeeded in exemplary schools like High Tech High, which start the school day with students planning their self-directed learning project. Making a variety of learning models accessible to communities would allow for different needs to be met, depending on local context, and drive toward equitable outcomes.
What Would Be Funded	An NCADEx could fund a set of innovative schools to experiment with different models of instruction as well as create a "school model profile" tool that potential recruited schools could complete to help match them to a model that works for their school needs
Examples of what this might look once implemented	Schools that have opted to participate in the program would undergo a scaffolded process. Primary programming activities would entail training and coaching cohorts of teachers in key interventions that would gradually transform direct instruction toward project-based learning, blended learning, or other models that have been evidenced to work optimally. A team of implementation specialists, teacher coaches, and other personnel would be available to partners to help ensure that there is uptake of new instruction models with fidelity.

Idea	**Identifying the next best instructional lesson for students**
Objective	Expand opportunities for personalized learning exercises.
Why It's Important	While auto-recommendations have been most used for commercial purposes (like Netflix), machine learning could be optimized to auto-recommend learning activities that are best fit to learners. A research team at Vanderbilt has already been experimenting with approaches to this problem.
What Would Be Funded	Develop a database of learning activities in target domains. Build a dataset of activities that are mapped to sample profiles of students with varying motivational, emotional, and prior knowledge backgrounds or conditions
Examples of what this might look once implemented	Any education platform could integrate a diagnostic assessment taking into account factors such as motivation, emotional state, and prior knowledge. The platform would then auto-scaffold differentiated activities that best suit the student. Additionally, the auto-recommender can deliver appropriate interventions such as worked examples or motivational messages. Building datasets and tools in this area would spark significant innovation and could help ensure that the right student is matched with the right intervention using the right model of learning support.

Idea	**Build Digital Catalog of Worked Examples**
Objective	● Have an extensive library of worked examples for teachers to use during lessons. ● Reduce students' cognitive load, allowing them to focus on the skills and knowledge being taught. ● Improve students' understanding of the subject matter. ● Make teachers' lesson preparation easier.
Why It's Important	Worked examples are very clearly solved problems, and studies show that worked examples help students learn. Why? Because if there's less distraction in a lesson or problem, students will build a deeper understanding of the concept being taught. This innovation would alleviate some of the lesson preparation burden on teachers and potentially improve teacher satisfaction and retention.
What Would Be Funded	Develop curriculum with worked examples as a core component of subject matter units. Create a database of worked examples that is easily accessible by all teachers.
Examples of what this might look once implemented	A database of worked examples would be aligned to standards and allow teachers to pull examples for their classes. Another option might be to embed the worked examples into other curriculum materials.

Idea	**VR tool to teach geometry, graphing, and algebra**
Objective	● Help students visualize graphs and data. ● Help students visualize 3D objects for problem solving.
Why It's Important	3D objects and graphs don't always translate well when drawn on a 2D board in the classroom. Virtual reality programs allow students to fully visualize the shapes they are working with in geometry and the graphs they are working with in algebra. Better visualization leads to better understanding of the underlying concepts.
What Would Be Funded	Development of VR technology designed for geometry and graphing instruction
Examples of what this might look once implemented	When students start learning 3D shapes in geometry, they use a VR program to create the 3D object. Also, when students work with graphs in algebra, they use a VR program to graph data and work out related problems.

Idea	**Identifying most effective teacher moves**

Objective	• Prompt teachers to teach and reflect on their current practices and note areas where they can improve • Model a process for how teachers can implement self-reflection and continuous improvement in their teaching design • Use AI to help teachers identify specific effective moves they can implement in teaching scenarios
Why It's Important	Many teachers have embraced self-recorded videos of their instruction as a way to get targeted feedback, and the past decade has shown sustained growth of instructional videos as a tool for teachers to reflect on their own teaching, get feedback from peers ("peer video clubs"), targeted coaching, and as eligible submissions in licensure processes. Pairing this self-reflection with the advances of AI to prompt teachers to try specific new moves for just-in-time support could help push them toward exercising teaching moves that they were unaware of or hesitant to try.
What Would Be Funded	Create a dataset of effective teaching moves that can be mapped to positive learning outcomes
Examples of what this might look once implemented	In a recorded training session, the teacher may be given a task to teach a sample lesson with a specific goal such as, "Ensure that all students are engaged." After viewing the recording of their teaching session, the teacher can then choose what aspect of their teaching they want to focus on, such as ensuring equitable talking time for all students. The teacher would be led into a similar teaching scenario, but with an AI available to prompt the instructor with specific moves. For example, the AI might intervene to ensure that all members of a small group are able to contribute to a discussion or activity, prompting the instructor to ask questions such as, "Nadia, would you like to finish your thought?" or "Dan, we will come back to your idea in a moment." Such tools would be particularly useful for instructors working with distance learners but might also be expanded using further research in physical engagement detection–such as eye contact or body orientation–for in-person instruction.

Idea	**Individual Career Plans for Students**
Objective	• Identify and clarify individual student learning goals. • Map instruction to the goals or objectives. • Individualize instruction, as needed, for students of all abilities.
Why It's Important	Student "maps," or plans, of learning opportunities have shown some success. Chicago has seen some success with this approach, for instance. Learning maps can also connect work and academic goals, and when students understand the goal of instruction, they can better understand how to study and achieve that goal.

	An innovation like this can be especially important for students in communities where access to professional networks and resources are limited.
What Would Be Funded	• Refinement of a massive dataset of learning outcomes or skills linked to a wider diversity of careers • Development of a predictive model that can take career interests and grade level and predict the required student learning goals with a timeline visualization of when the student might strive to achieve key learning goals
Examples of what this might look once implemented	Each student has an online learning map. It runs on data about the student's career interests, grade level, and skills acquired thus far, as well as data collected about various professions. If, for example, a student wants to become a CEO of a hospital, it gives a clear path from eighth grade through college and their career. A timeline visualization can help students get a birds-eye view of what they need to learn, while a "zoom in" function could provide a sense of direction through sub-learning goals.

Idea	**Course equivalency recommender and dashboard**
Objective	Provide students an infrastructure to transfer skillsets and course credits with them if they were to change educational paths, whether from higher education to vocational programs (or vice versa)
Why It's Important	Leveraging skills data in academic platforms and programs could help ensure that investments in students' higher education and career programs are likely to meet labor demands and lead students to gainful employment. It would also hold faculty and instructors accountable to ensuring that course learning objectives and outcomes are relevant to learners' interests and expectations. "Course equivalency recommendation systems" is one idea that is being explored. Such an idea would help students consider the transferability of skills if they were to change educational paths from higher education to vocational programs and vice versa. Provided a strong infrastructure and cooperation between universities, colleges, vocational/TVET programs, the equivalency recommendation system would also allow students to transfer credits across programs, allowing greater mobility and choice for students.
What Would Be Funded	• A comprehensive database of academic activities' outcomes that can be linked to labor force skills and abilities data indicators using resources such as the Department of Labor's O*Net Program (contains occupation-specific data for nearly 1,000 occupations represented in the national economy)

	● A model to help visualize the specific skills associated with careers ● A model that can predict skills acquired through coursework, recommended career paths based on skills acquired, and recommended paths based on expressed interests
Examples of what this might look once implemented	A student starts with logging into their LMS and takes a quick assessment to gauge their readiness and intent to change paths or explore a new path. Other questions in the diagnostic would account for factors like time and costs to embark on an educational path. Based on this information, along with the coursework that the student is enrolled in and data on their assignments, the course equivalency recommender can recommend the skills the student has already gained, and how long and which courses or other resources would be needed to complete, change, or explore a path. Alternatively, the recommender can suggest other career paths that the student could feasibly succeed in but had not considered. Additionally, teachers, administrators, counselors, and others can view this data to help determine if a student is on track for admission or transfer to a program.