Igniting K-12 Education R&D to Spark Innovation and Accelerate Learning:

The Alliance for Learning Innovation's 2024 Federal Policy Recommendations

Alliance For Learning Innovation

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SUMMARY

To meet the many serious challenges confronting American education, innovative new approaches are needed. Acute learning loss from COVID-19, coupled with a long trajectory of underperformance, jeopardizes students' futures and the nation's competitiveness. Pandemic learning loss alone is predicted to result in a $14.2 trillion decrease in GDP. To accelerate the pace of learning recovery, a smarter and more robust investment in education research and development (R&D) is needed. There is an opportunity to build on existing research to create an education system that develops and leverages proven tools and methods, including those outside a traditional classroom setting; addresses individual student needs; and improves equity.

At present, the infrastructure for creating, studying, and implementing what works in education is woefully lacking. The U.S. devotes few and declining resources to R&D in education—a staggeringly low 0.4 percent of the U.S. Department of Education's (ED) entire budget. Given the importance of R&D as an engine for change, this deficit holds the education system back and contributes to stagnation and decline in student performance, especially among disadvantaged students whom the current system was not designed to serve, and especially relative to competitor nations.

Fortunately, there is a great deal that can be done to reverse these trends in education. It is a promising time to pursue a more aggressive innovation strategy for several reasons. The recent National Assessment of Educational Progress scores show dramatic declines in math and reading scores. Students of color and low-income students need more opportunities, and economic changes demand a higher level of educational attainment for all students. Finally, the nation needs more robust economic growth and innovation to compete with countries like China. Changing the nation's current trajectory will require a bold, coordinated response among researchers, developers, practitioners, and system leaders, including new strategies for encouraging adoption of research-backed tools and resources.

The Alliance for Learning Innovation (ALI) is calling for this bold effort. Bringing together a wide coalition of groups from both sides of the political aisle, ALI is well positioned to advocate for federal investments in education and workforce development that will foster research-based innovations in education. As a coalition, ALI advocates to modernize and increase the investment in federal education R&D, and to ensure community input and equity are at the center of this work. ALI calls on federal leaders to:

- ***Enhance federal, state, and local education R&D infrastructure.*** This includes bolstering R&D capacity at the Institute of Education Sciences (IES) by establishing a National Center for Advanced Development in Education (NCADE), a DARPA-like division that would catalyze breakthroughs in teaching and learning; and by creating a data science unit to fully leverage the agency's wealth of data and gain a richer set of insights. To maximize the potential of existing data systems, there should also be an effort to grow and modernize the Statewide Longitudinal Data Systems (SLDS) program and scale up the "Learning Pulse" hosted by IES's National Center for Education Statistics early in the COVID-19 pandemic. IES should foster a "Doing What Works" network of states to come together around high-priority issues and share evidence around high-quality solutions.

- ***Support the development of diverse education R&D talent.*** Federal leaders should expand the National Science Foundation's (NSF) Data Science Corps, a program that develops the skills and job prospects of students in higher education who come from diverse backgrounds, and IES should offer "data science fluency training grants" to academic researchers, especially at Historically Black Colleges and Universities

(HBCUs) and Minority-Serving Institutions (MSIs), to build the skills of those who are underrepresented in the education research community. Additionally, IES should establish a "rotator program" that would bring in talent with advanced expertise to complement the skills of their current staff.

- ***Invest in evidence-based methods.*** More should be done to expand and diversify ED's Education and Innovation Research (EIR) program to scale up programs proven to increase student achievement. Additional investments should also be made through ED's Office of Career and Technical Education to ensure the best evidence-based methods are deployed to prepare students for the changing workforce.

- ***Drive collaboration across IES and NSF.*** The CHIPS and Science Act established NSF's Centers for Transformative Education Research and Translation and encouraged partnership between NSF and ED to support these new centers. This collaborative approach should be supported, as it will enhance learning across the agencies and improve outcomes overall. AI Institutes offer another example of NSF-ED collaboration that merits additional investment. In 2021, IES and NSF worked together to fund AI Institutes in education, which resulted in early successes. These AI Institutes should be expanded.

- ***Invest in K-12 education R&D at NSF.*** Fully fund K-12 education R&D initiatives within the STEM Education (EDU) and Technology, Innovation, and Partnerships (TIP) Directorates. Specifically, ensure adequate funding for the Centers for Transformative Education Research and Translation and rural STEM educator grants, newly established through the CHIPS and Science Act.

- ***Increase IES's efficacy through increased funding and a commitment to equity.*** Grow investments across existing IES programs and promote equity by following the recommendations made in the National Academies' 2022 report on *The Future of Education Research at IES: Advancing an Equity-Oriented Science*.

CHALLENGE AND **OPPORTUNITY**

The American education system is failing to consistently deliver high-quality learning experiences to students, especially those from marginalized backgrounds. Before the COVID-19 pandemic, achievement gaps were already proving recalcitrant, with significant racial gaps declining only gradually since the 1970s and income-based gaps remaining static.

The pandemic widened these gaps, as revealed by recent data from the National Assessment of Educational Progress (NAEP). Students nine years of age experienced the largest drop in reading scores since 1990, and the first-ever decline in math scores. From 2020 to 2022, 9 year-old students' reading scores dropped an average of 5 points while their math scores fell 7 points. Students with disabilities experienced an even sharper decline in reading and math scores (by 7 and 8 points, respectively). An Annenberg Institute report found that achievement gaps between low-poverty and high-poverty schools, across rural and urban settings, are "20% wider in math and 15% wider in reading relative to before the pandemic." Meanwhile, a McKinsey report similarly found students in low-income, majority-Black, and majority-Hispanic schools experienced more unfinished learning than high-income and majority-White schools during the pandemic. While the challenge is steep, it is not insurmountable. An investment in education R&D infrastructure that ensures leadership by, and opportunity for, people from marginalized backgrounds can lead to meaningful innovations for students impacted by inequity.

If these trends in education are ignored, the U.S. will not only forgo an opportunity to improve students' educational and life outcomes, but also to grow our economy. There is a broad base of evidence for education's return on investment—particularly in labor market participation and earnings. A 2015 National Bureau of Economic Research (NBER) study demonstrated that increased math and literacy skills can improve wages by 27 and 28 percent, respectively. An analysis of the NBER study's results indicates that just by boosting math skills, the U.S. economy would see an additional $235 billion in earnings annually.

Internationally, competitor and peer nations routinely outpace the U.S. in comparisons of academic achievement. This is especially true in science, technology, engineering, and math (STEM) subjects. For example, the U.S. ranks 30th in math among Organisation for Economic Co-operation and Development (OECD) countries. This is below average for the group and well below the Chinese regions tested, which rank at the top. A Georgetown University report found that this educational deficit extends all the way through postgraduate education, where China is outpacing the U.S. in producing STEM PhDs.

Low academic outcomes will not only fuel negative economic consequences for students and the country, but could also jeopardize national security. A Department of Defense report warns of a "permanent national security deficit" in part due to the decline in STEM education. It concludes, "The U.S. must create a state-of-the-art STEM education strategy to cope with this reality."

U.S. R&D SUCCESSES

For decades, the U.S. has been a leader in technology and innovation by investing in R&D, but it recently slipped to ninth in R&D investments by GDP, according to the OECD. One of the most well-known examples of U.S. R&D success is DARPA (the Defense Advanced Research Projects Agency), which was authorized in 1958 by President Eisenhower in response to the launch of the Soviet satellite Sputnik. DARPA was given a flexible project-based structure to explore new "moonshot" technologies for military and other purposes. In the decades since, DARPA has been behind some of the nation's most significant innovations, including the internet (initially called ARPANet), GPS, AI and speech recognition, advanced robotics, and prosthetic limbs.

R&D investments have also helped solve significant problems in energy and agriculture. Following the 1970s energy crisis, the Department of Energy (DOE) pushed for technological innovation to increase American energy independence. DOE's research eventually helped lead to the shale gas revolution, which made the U.S. into a net exporter of natural gas in 2017. R&D at the Department of Agriculture (USDA) has led to the production of drought- and flood-resistant crops, as well as technologies to improve crop yields.

Healthcare is another sector where investment in R&D has fueled significant progress. From 1999 to 2003, the Clinton and George W. Bush administrations, along with Congress, doubled the budget of the National Institutes of Health (NIH) to over $27 billion. The increases were designed to improve treatments for cancer, HIV/AIDS, and other diseases. Since then, continued development of new antiretroviral drugs has helped to render HIV/AIDS a manageable condition for many who would otherwise have died from the disease. Numerous cancer therapies, including the first cancer treatment vaccine, have been developed.

More recently, R&D investment has helped the country to emerge more quickly than predicted from the worst stages of the COVID-19 pandemic. NIH funding contributed significantly to the development of the mRNA vaccines against COVID-19, especially the Moderna vaccine, whose patent names NIH investigators as co-inventors. Moreover, the early technology for mRNA vaccines grew out of a 2011 DARPA project.

When the federal government invests in education R&D, it pays off. For example, ED's Education Innovation and Research (EIR) program (including through its predecessor program, Investing in Innovation, or i3), scaled up the Building Assets-Reducing Risks program and the impact was significant. This program took a data-driven, cohort-based approach to easing students' transition from middle to high school and it resulted in students earning markedly higher grade point averages in core classes by the end of 9th grade. The results were even more dramatic for initial low-performers. The EIR-funded ASSISTments tool, an online formative assessment tool, offers another example of federal education R&D increasing student achievement. Through EIR, ASSISTments was able to reach high-need middle school math students at over 150 schools. As a result, more kids got to benefit from an intervention that leads to a 75% increase in learning in two years.

IES' Small Business Innovation Research (SBIR) program also shows the positive impacts of federal education R&D investment. SBIR provides small businesses with critical funding to turn their innovative ideas into viable commercial products that tackle educational challenges and stimulate the economy. It has led to developments such as Agile Mind, Inc. 's online biology modules with real-world visualizations to enhance discovery-based learning, FabMaker Studios' web-based design and fabrication tool that teaches engineering and math to elementary and middle school students, and IRIS Connect's secure video-based platform that allows teachers to analyze and improve their teaching practice.

NSF education grants have also resulted in improved outcomes for kids. One NSF grant enabled the "Engineering is Elementary" project to create engineering activities for students in first through fifth grade to engage in as part of their science curriculum. An evaluation of "Engineering is Elementary" revealed that students who engaged in it had 13 percent larger gains in engineering learning than students who followed a control curriculum; and 24 percent better outcomes in science than the other students. NSF's SBIR program has spurred the development of promising educational technologies like Muzology, an award-winning learning platform, grounded in psychology and music, that gets students excited about math. Students who used Muzology during the pandemic increased their math proficiency by two years, while other students fell behind.

These investments and outcomes show the potential of the federal R&D engine to be a driver of positive change that is desperately needed in education.

U.S. DEFICITS IN **EDUCATION INNOVATION**

Despite decades of stagnation and widening gaps in educational attainment and outcomes, the federal investment in education R&D—especially development—pales in comparison to the federal investment in other areas.

Let's look at some of the numbers. From 2000 to 2020, according to data on federal R&D by budget function from the NSF, R&D investments in health across federal agencies increased by around 125 percent, from $18 billion to over $40 billion. Other fields that have seen high-impact innovation, like agriculture and energy, have also seen significant R&D increases over the same period: 68.5 percent and 362 percent, respectively.

By contrast, from 2000 to 2020, R&D funding in the combined field of "education, training, employment, and social services" has risen from $429 million to just $589 million, an increase of 37 percent—outpaced by the 50 percent overall rate of inflation during this time. This means that, in reality, the nation has *divested* in education R&D.

The inadequacy of the investment in education R&D was especially clear during the pandemic. While the healthcare and pharmaceutical sectors were able to respond with a great deal of success to the challenge of the pandemic, school systems struggled. Schools and teachers did not have the tested tools they needed to adjust to the new environment. Meanwhile, many parents and students felt abandoned by the education system, with only confusing and ineffective tools given to them to replace in-person learning.

The field of education R&D holds a great deal of potential. Research in education, learning science, human development, and cognitive science has developed significantly in recent decades. Research on retrieval practice, for example, which has been supported by both the IES and NSF, has demonstrated the value of low-stakes testing and self-quizzing, and the relative ineffectiveness of passive review exercises, like re-reading a textbook or going over notes. Furthermore, research supported by IES has generated new insights into the importance of metacognition, reflection on one's own thinking processes. These insights have revealed its educational significance, especially in cultivating high-level skills like critical thinking and collaboration.

Similarly, on the technological front, advancements in artificial intelligence and natural language processing have shown ample opportunity for effective educational applications when combined with strong research backing. Progress has already been made in developing automated writing feedback tools, intelligent tutoring systems, and tools for diagnosing reading problems.

But the lack of a sophisticated, systematic, and well-funded approach to the "development" side of education R&D means that most of the opportunities uncovered in the research have not yet been seized. The findings of the science of learning and development, such as insights on metacognition and context, remain poorly integrated into educational training, practice, curriculum, and learning tools. Teachers are rarely given clear and easy-to-implement, research-backed strategies and, as a result, are seldom put in a position to use research insights to improve their teaching. Educational technologies and materials have proliferated, but too often their evidence base is thin or non-existent, and school districts are forced to make acquisition decisions without a clear understanding of what will work best for their students. Incentives to encourage adoption of proven tools and pedagogical techniques are also lacking.

There's a clear need for greater government involvement to strengthen and give direction to education R&D programming. To build a more effective federal education R&D engine that will drive better outcomes for all students and enhance American competitiveness, a significant and concerted investment in education R&D, along with new approaches and policies, is needed.

PLAN OF **ACTION**

RECOMMENDATIONS FOR **CONGRESS**

Because of the historic pandemic learning loss and the unique opportunity to improve K-12 education in and outside of the classroom, Congress should be ambitious in increasing and retargeting education R&D spending. Not only will this have a significant effect on outcomes for students but also for national security and economic prosperity. Specifically, Congress should invest in education R&D within ED and NSF, and with additional attention to the "development" part of R&D. The current low levels of education R&D funding necessitate a bold effort to build the field and spur innovation to help improve a struggling system, open up opportunities for high-need students, and bolster American competitiveness.

As ED's center for R&D, IES should be at the forefront of this effort. Increased funding should be directed both to improve and scale existing research programs across the agency and to establish new programs. Specifically, ALI's recommendations include the following:

- ***Establish a National Center for Advanced Development in Education (NCADE).*** Modeled after DARPA, NCADE would support large-scale, innovative projects that require a more nimble and responsive program management approach than currently in place. Specifically, NCADE would fund projects developed by universities, industry, and innovative organizations, selected based on their potential to create

dramatic breakthroughs in learning and teaching, especially for the most underserved populations. Like DARPA, NCADE would be oriented toward ambitious ideas across the academic, public, and private sectors. It would build on bipartisan interest in expanding education R&D, and put outcomes for kids at the center of its work. The Center would focus on breakthrough technologies, new pedagogical approaches, innovative learning models, and more efficient, reliable, and valid forms of assessments. This federal investment would spark innovation at state and local levels, and help build local infrastructure to sustain the work. Some examples of ambitious projects that NCADE could pursue include:

  - Scalable tools to accelerate learning and help students—especially the most adversely affected, underserved student populations—effectively make up for lost learning due to the pandemic or other learning disruptions
  - Innovative learning models that bundle together an interconnected set of tools, resources, systems, and instructional practices to shape student learning experiences toward clear objectives
  - Automated feedback on student writing and math homework that leverages advances in natural language processing, giving teachers new digital aids to support student improvement
  - New, proven approaches to teaching high-level skills, like critical thinking, collaboration, and problem solving, which are highly valued in higher education and the workforce but not typically a focus of traditional curriculum

- ***Build state and local R&D capacity.*** Congress should fund a matching competitive grant program for states to build capacity for and engage in education R&D. These funds would allow state or local education agencies (SEAs or LEAs), or consortiums of SEAs and LEAs, to develop individualized strategies to advance state and local education R&D. Eligible entities would propose capacities they need to improve education in their state or district, which might include leveraging large-scale data or developing new approaches or supports for instruction. The program would facilitate the development or implementation of infrastructure to support diverse approaches specifically tailored to state and local contexts, including building research-practice partnerships, recruiting research and data talent into their agencies, and investing

in their own R&D priorities to develop or implement more evidence-based solutions. This ground-up approach to innovation will allow for a wealth of pilot programming to see what works and scale it up in new contexts while also developing the capacity of state and local leaders to meet their own education R&D needs rather than being wholly reliant on the federal government.

- ***Grow the Statewide Longitudinal Data Systems (SLDS) program.*** The SLDS program helps states build longitudinal data systems to track student progress through K-12 and into the workforce. Since the start of the program in 2005, several states have built robust systems that connect student data across systems and programs. These systems have facilitated groundbreaking research, and provided educators and policymakers with insights into long-term education outcomes. They have also enabled a greater focus on equity in policy making by facilitating more careful analyses of what policies and interventions drive subgroup and individual student performance. But additional funding is needed to modernize system architecture and infrastructure, link data into workforce systems and across states, protect student privacy, and help generate accurate data to help policymakers understand and address achievement, equity, and opportunity gaps. Improved systems will increase the capacity for and speed of research so that school districts and postsecondary institutions know more quickly what is working and what needs to be improved.

- ***Support a "Learning Pulse."*** Accurate, timely data and the capacity to draw insights from diverse sets of data are crucial for understanding student needs and challenges experienced during the COVID-19 crisis and beyond. Interrupted learning due to COVID was not evenly distributed across the education system, nor are other systemic challenges millions of students face such as connectivity, transportation, and, of course, public health as the population continues to adjust to COVID-19. All of these factors must be understood for effective response and recovery. At the beginning of the pandemic, the School Pulse Panel hosted by IES's National Center for Education Statistics (NCES) helped address some of these problems by tracking enrollment, school closures, and learning loss. But funds are needed to scale up the program and make it permanent. A more robust "Learning Pulse" program would

provide actionable information in a more sophisticated and timely manner, and help school leaders more rapidly understand the relationships between various social and technological systems.

- ***Grow and Modernize Existing IES Programs.*** Increase federal investments across the agency to strengthen current programs. Support IES in making a deeper commitment to equity and utility by implementing the recommendations made in the National Academies of Sciences, Engineering, and Medicine's 2022 report on The Future of Education Research at IES: Advancing an Equity-Oriented Science, and by investing in the capacity of HBCUs, MSIs, and Tribally Controlled Colleges and Universities (TCCUs) to be leaders in education R&D.

Outside of IES, investments in other ED programs, as well as in related work at the NSF, can have a significant impact as well. These program improvements and expansions include:

- ***Expand and diversify the Education and Innovation Research (EIR) program in the Office of Elementary and Secondary Education at ED.*** EIR has been successful in advancing evidence-based innovation, particularly in computer science. The program provides support to education researchers to create, implement, and scale innovative and evidence-based programs to improve student achievement. As a complement to the other R&D efforts as part of this proposal, additional funds for EIR would expedite the implementation and expansion of ideas that show promise, build out the evidence base of what works, and do more to involve historically-excluded institutions and groups in the R&D process.

- ***Support college-readiness and career pathways.*** The Office of Career and Technical Education (CTE) at ED has made significant strides in developing CTE programming that prepares students for the workforce. More funding is needed, however, for evaluating and modernizing this programming across the country to ensure the best evidence-based methods are put into practice to prepare students for the changing workforce. Investments in innovative workforce development models are also needed, especially as it relates to career pathways.

- ***Carry out the commitment made to STEM education in the CHIPS and Science Act. Congress should fund the newly authorized Centers for Transformative Education Research and Translation.*** These centers will foster collaboration among NSF, ED, and state and local districts to scale up promising innovations in PK-12 STEM education. Additional funding should support the NSF's CHIPS-authorized grants to prepare rural educators for high-quality STEM instruction.

- ***Invest in education programs in NSF's STEM Education (EDU) and Technology, Innovation and Partnerships (TIP) Directorates.*** Congress should provide more funding for the EDU Directorate at NSF, which advances STEM education at all levels and supports programming to develop the future STEM workforce. New funding should also be directed toward the new Directorate of Technology, Innovation, and Partnerships (TIP) to make STEM education and education research a focus area of the new Directorate.

- ***Expand AI Institutes at NSF.*** Additional investments in programs that cross-cut both NSF and IES will also drive the federal engine for education R&D. In 2021, IES and NSF came together for the first time to fund AI Institutes in education. To take one example, the National AI Institute for Adult Learning and Online Education has produced valuable research on improved workforce training, using AI to teach argumentation and advancing equity in online learning. Increased funding would build on these early successes and allow the programs to be scaled.

- ***Expand the Data Science Corps (DSC) at NSF.*** Currently, the Data Science Corps provides practical experiences and skill development to undergraduate and Master's degree students from diverse backgrounds. Additional funding would allow this successful program to expand to K-12, ensuring that students gain exposure and build skills to compete for the growing pool of jobs that require data science expertise. As it scales to K-12 education, the DSC should coordinate closely with IES.

RECOMMENDATIONS FOR **THE ADMINISTRATION**

To realize these new priorities in education R&D, additional leadership is needed from the executive branch. It should propose additional funding for new programs, modifications to existing programs, and executive action that complements and enhances these changes. Leadership from the Administration can help ensure that the education R&D ecosystem is working seamlessly across agencies to advance these priorities and make progress on learning gaps and deficits.

- ***In the President's 2024 budget, make robust requests for education R&D funding.*** This entails strong investments in education R&D programs at IES and NSF. Within ED, increased funding should be directed across all existing IES programs and to establish NCADE, enhance SLDS, expand EIR, and support a "Learning Pulse" and evidence-based CTE programming. The President should also call for an investment in the new Centers for Transformative Education Research and Translation, as well as grants for rural STEM educators, at NSF. Additionally, the President's Budget should request funding to expand R&D infrastructure at HBCUs, MSIs, and TCCUs.

- ***Support a data science unit at IES.*** To leverage new technological developments in machine learning, natural language processing, and other sectors, greater technical capacity and knowledge is needed at the federal level. The Administration should support a data science unit that would be housed in IES. More robust data science capabilities within IES would improve the agency's ability to gain insights through the integration of approaches from fields such as computer science, data mining, statistics, and predictive analytics. A data science team would also ensure that IES has the expertise to maximize the value of the agency's rich data assets.

- ***Invest in digital learning platforms and data as research infrastructure.*** Digital learning platforms offer researchers an opportunity not only to test research hypotheses rapidly and at scale, but to deploy what works based on those insights. IES should continue to build upon its digital learning platform research network grants, which allow research teams to work together to leverage digital learning platforms and rapidly interrogate new research inquiries at scale. IES should also do more to build out large-scale datasets that allow new AI tools to hone models while allowing algorithms to be interrogated for bias.

- ***Support "data science fluency" training grants.*** IES should support training grants to teach academic researchers to be "bilingual" across data science and domain challenges in education. Much of this training money could be directed to HBCUs and MSIs to build up a cadre of skilled education researchers who are currently underrepresented in today's education research community. Additional funding should be provided for IES to address and implement recommendations from its Increasing Diversity and Representation of IES-funded Education Researchers Technical Working Group report.

- ***Support a rotator program at ED.*** To build internal capacity to implement education R&D priorities, IES should create a "rotator program" with the authority from the Intergovernmental Personnel Act to engage advanced scientific and technical expertise. NSF's rotator program is instrumental in ensuring the agency's program reflects creative ideas from the field and the most advanced computational methods. Both IES and ED more broadly could greatly benefit from a similar program.

- ***Support a "Doing What Works" state network.*** Under current law, IES can support a network of states to work together to build capacity around research-based practices. The first network might be focused on high-dosage (otherwise known as high-impact) tutoring, helping states identify and share evidence and information on high quality programs and practices. Subsequent networks would focus on high-priority issues raised by the states including focusing on issues of equity and end users. The program could run as a request for proposals within the National Center for Education Research in IES.

CONCLUSION

This comprehensive set of investments and recommendations will help develop an education R&D field that drives sustainable, efficient, and equitable improvement to the nation's education system. Federal agencies will be provided with the talent and resources they need to identify and invest in proven interventions; SEAs and LEAs will be able to develop research partnerships and programming that generate context-sensitive knowledge and methods; and teachers and students will benefit from robust, evidence-based solutions that they can use with confidence. The result will be an integrated R&D engine that produces positive educational, economic, and societal outcomes for generations to come.

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