

Ingredients of a Competitive ITEST Proposal



ITEST
Program Officers
June 2022



Agenda

1. Overview & Demystifying ITEST
2. Major changes in the new solicitation
3. Project Categories, Funding Levels & SEI
4. Required ITEST Pillars
5. Research & Evaluation
6. ITEST's Emerging Workforce Priorities



Overview

- ITEST is an applied research and development program with goals to advance the equitable and inclusive integration of technology in the learning and teaching of science, technology, engineering, or mathematics (STEM) from pre-kindergarten through high school.
- The program's objective is to support all students' acquisition of the foundational preparation in STEM disciplines. **Preparation for the current and future workforce is increasingly dependent upon the application and use of technology and computing.**



Overview

- ITEST is responsive to societal needs and emerging areas of STEM and related careers.
- Emerging areas may include, but not limited to, quantum computing, artificial intelligence, computational thinking, cybersecurity, environmental science, and STEM entrepreneurship.
- ITEST welcomes proposals with well-designed strategies to integrate these emerging areas into effective learning and pedagogical innovations.



Demystifying ITEST

ITEST only funds proposals situated in formal education

ITEST funds projects in both formal and/or informal settings.

ITEST proposals are primarily submitted by people from K-12 schools

Most PIs are university faculty, and STEM educational leaders and researchers from other organizations such as museums, libraries, etc. PIs are encouraged to work with PreK-12 schools, informal learning organizations or other related organizations to develop ideas for their proposed activities.

University faculty members and student cannot be paid because ITEST is a program targeting PreK-12 students

PIs can budget stipend for university faculty members, undergraduate and graduate student assistants as they do for other research programs

Colleges/universities cannot charge indirect cost because ITEST is a program targeting PreK-12 students

A college/university can charge indirect cost as they do for other research programs and the rate of charging indirect costs stays the same.



Demystifying ITEST

My university will not reward me for my grants on supporting PreK-12 education

We recommend that you check with your chair, dean, and provost about this. We know that many universities have recognized and rewarded faculty's contribution for K-12 STEM education in the tenure and promotion process.

ITEST just focuses on "outreach"

ITEST is an R&D program that supports innovative technology experiences for preK-12 students and teachers. Competitive proposals should incorporate research in a way that contributes to national efforts to support increased participation in STEM education and careers.

ITEST is about fun after-school experiences

ITEST can support experiences in any location and any time that matches with the goal of supporting increased participation in STEM education and potential careers. ITEST projects could take place at schools, community locations, museums and science centers, or at university or industry sites, and occur before, during, or after regular school hours as well as in the summer or on weekends as appropriate for the project's goals.



Major Changes in the New ITEST Solicitation



ITEST Pillars - **Required** in proposal narrative

- Pillar 1: Innovative Use of Technologies in Learning and Teaching
- Pillar 2: Partnerships for Career and Workforce Preparation
- Pillar 3: Strategies for Equity in STEM Education



Solicitation Specific Review Criteria

- **Required** in proposal narrative

To what extent does the proposal:

1. Include explicit and adequate strategies for recruiting and selecting participants
2. Describe approaches to address diversity, access, equity, and inclusion
3. Describe research-informed instructional approaches to build on strengths and challenges
4. Explain how innovations with technology are developmentally and age-appropriate



Major Changes in the New ITEST Solicitation

Summary

1. ITEST Pillars - **Required**
2. ITEST Solicitation-Specific Review Criteria - **Required**
3. Required components for proposals in Section B of the Program Descriptions
4. Project types and maximum budget for each type
5. Proposal submissions must be
 - via Research.gov or Grants.gov
 - in accordance with the revised *NSF Proposal & Award Policies & Procedures Guide* (PAPPG) (NSF22-1)



Project Categories & Funding Levels



Funding level changes for each project type

- Exploring Theory and Design Principles (ETD): ~~\$400,000~~↑; **NOW \$500K**
- Developing and Testing Innovations (DTI): ~~\$1,500,000~~↓; **NOW \$1.3M**
- Scaling, Expanding, and Iterating Innovations (SEI): ~~\$3,000,000~~↑; **NOW \$3.5M**
- Syntheses: ~~\$300,000~~↑; **NOW \$400K**
- Conferences: \$100,000. **NO CHANGE**
- Resource Center: ~~\$4,000,000 in FY 2020~~↑. **NOW \$5M**



Scaling, Expanding, and Iterating Innovations (SEI)

Up to 5 years

Up to \$3,500,000

- Broaden an innovation at a significant scale
- Extend innovation to new populations, regions, ages, contexts
- Research should be transferable and generalizable to scale
- Assess cognitive & soc-emo outcomes, STEM/ICT knowledge & or career pursuit

Resource Center: A separate webinar will be held.



Scaling, Expanding, and Iterating Innovations (SEI)



What Qualifies as a SEI Project?

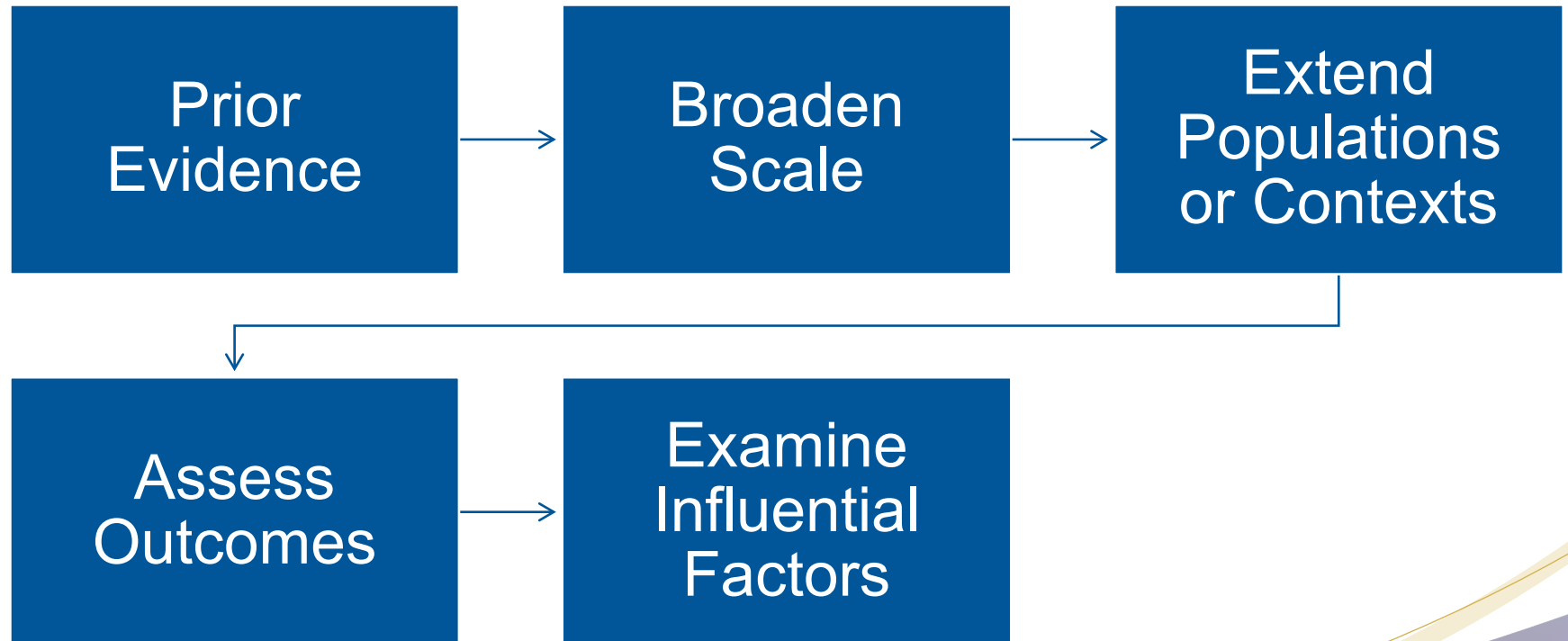
- SEI projects build on and expand an existing innovation that has evidence of success
 - broaden the implementation and research of an innovation at a significant scale of five to ten times greater than the original implementation.
 - extend an innovation to different student populations, regions of the country, grade levels or ages of students with varying skills, and educators' capacities in PreK-12 formal and informal settings.
 - examine issues of transferability and generalizability and the factors that support or inhibit scaling; and
 - assess cognitive and social-emotional student outcomes and measure student STEM knowledge and whether students continue to pursue further STEM and ICT education or careers.



SEI Proposals must address all of these

SEI proposals must address all five aspects.

Depending on your focus, some may be addressed in more depth than others.



Conceptualizing a SEI Project

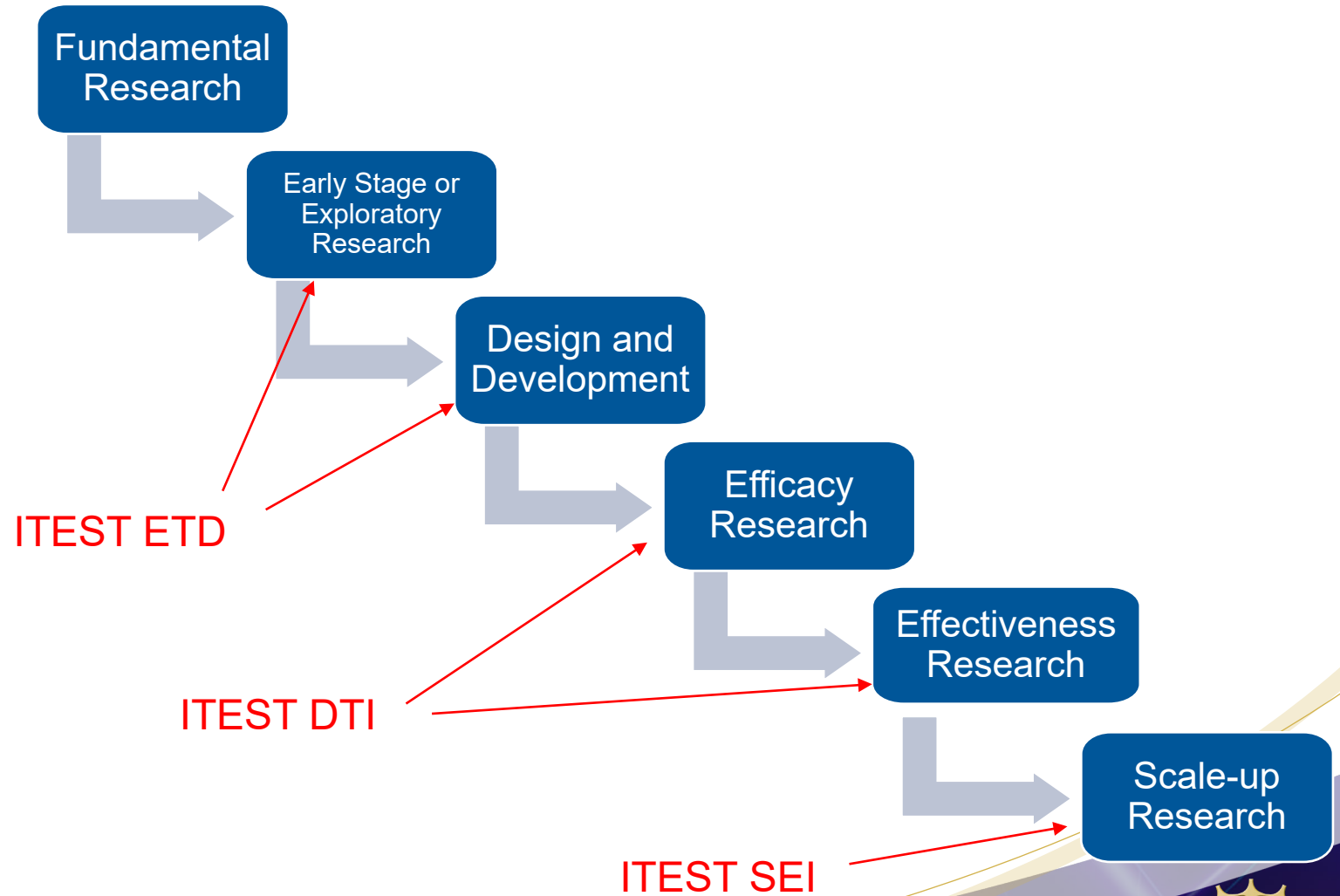
NSF 13126

Common Guidelines for
Education Research and Development

A Report from the Institute of Education Sciences,
U.S. Department of Education

and the National Science Foundation

August 2013



<https://www.nsf.gov/pubs/2013/nsf13127/nsf13127.jsp>

Elements of a Competitive SEI Proposal

Evidence of
Effectiveness

Dimensions of
Scaling

Contribution to New
Knowledge

Broadening Impacts

Feasibility

Rigorous Evaluation



Three REQUIRED ITEST Pillars



Pillar 1: Integrating Technology in Learning

ITEST requires that proposed activities engage learners in the use of technologies that will support acquisition of the foundational preparation in STEM and information and communication technologies.

When responding to this Pillar consideration should be given to:

- How specific disciplinary concepts will be taught.
- How the proposed technology will be used to innovate learning, improve or deepen students' conceptual and disciplinary understanding, critical thinking skills, development of disciplinary competencies, and evidence-based decision-making and reasoning.
- It is not sufficient for students to gain only experience in how to use technology. Students need to learn the creative ideas and STEM knowledge behind technology,



Define the proposed technology

Pillar 1: Integrating Technology in Learning

- What is the specific technology being proposed?
- Justify the technology by discussing how it aligns with national **workforce** priorities?
- What are the learning challenges of participants and how will the technology be used to address those issues, such as:
 - Why does the choice of technology make sense for participants?
 - How, and in what ways will the use of the technology improve or innovate learning?
 - What background research is critical to understanding/justifying how the technology is to be used?
 - How does the use of technology align with or challenge current educational practices?
- How can our understanding of how learners learn with technology be advanced through the proposal's scholarship and practice?



Pillar 1: Integrating Technology in Learning

Describe the technology's affordances

- Make a case for how the technology's affordances are potentially useful for innovating STEM learning.
- Discuss the key design features of the technology, including grounding in relevant scholarly literatures and/or evidence from practice; how the intervention provides innovative STEM learning experience with age and grade appropriateness, and contributes to broadening participation of students underrepresented and/or underserved in STEM; how the learning process itself will be studied to understand how and under what conditions the technology may have an effect on students' STEM learning.



Pillar 1: Integrating Technology in Learning

Define the STEM discipline(s) to be integrated with technology

- Describe the focal disciplinary or transdisciplinary content, concepts, and practices to be integrated with technology *as a learning process*.
- Discuss the **discipline-specific uses of the technology** important for learners to gain experience with, including STEM workforce/career relevance.
- Discuss how students' engagement with the proposed *technology-integrated* disciplinary learning can strengthen disciplinary knowledge; explain measures for cognitive outcomes (changes in knowledge) and social or affective outcomes (changes in motivation, engagement, interest, dispositions, or attitudes) and how they are appropriate for the participants.



Pillar 1: Integrating Technology in Learning

- Defining the integration process
- Describe the curriculum and instructional design of the integrated learning process.
- Describe how the learning process will be scaffolded between the discipline and the technology.
- What effects on teaching and learning as an integrated learning process will be studied?
 - Discuss the research questions that will investigate how to use technology effectively and innovatively in the context of disciplinary learning.
 - Provide clear articulation on how the integration process will be studied and measured.



Implications for future research

Pillar 1: Integrating Technology in Learning

What field-advancing knowledge and innovation of learning can be generated by studying the effects of the integration process on learning with technology?

- **Integrating disciplines** can develop greater capacity to think across disciplines to solve complex problems.
- **Integration of knowledge**, theories, methods, and data from multiple fields can inform new and expanded frameworks for addressing both scientific and societal challenges.
- **Integrating expertise** across fields can evolve new products, frameworks, paradigms and even disciplines that could not otherwise be conceived by one discipline.



Pillar 2. Partnerships for Career and Workforce Development



Call to Investigators

- Reach out beyond your own community
- Attend to voices, knowledge, and experiences
- Identify and define opportunities for workforce preparation



Describing this Pillar

- The role of the partnership
- The incorporation of values and diverse perspectives
- The implementation of a collaborative theory of action



Pillar 3. Strategies for Equity in STEM Education



Pillar 3. Strategies for Equity in STEM Education

- 1. Operationalizing.** What are the inequities your proposed strategies seek to address?
- 2. Conceptualizing.** How are your strategies for equity in STEM exploring (ETD) or building (DTI) on theories, methodologies, and/or design principles?
- 3a. Connecting to Pillar 1.** How are the proposed innovative uses of technology equitable? In what ways are you considering the "end-users" (SSRC)?
- 3b. Connecting to Pillar 2.** How are the partnerships for career and workforce preparation equitable? Are the voices, knowledge, and experiences of communities most impacted at the center of strategic partnerships?



Research and Evaluation



Research and Evaluation

Relates to the Merit Review Criteria questions:

What is the potential for the proposed activity to advance knowledge and understanding within its own field or across different fields ?

Does the plan incorporate a mechanism to assess success?



Relation between Research and Evaluation

Objectives of Research

- Developing understanding of the project elements, processes and outcomes
- Developing valid and reliable measures of important learning processes and outcomes for students and teachers
- Addressing fundamental questions or issues significant to the field
- Advancing new knowledge and evidence base on important questions

Objectives of Evaluation

- Is the project making satisfactory progress toward its goals?
 - Recommending evidenced-based adjustments to project plans.
- To what extent are the products and processes effective?
 - Attesting to the integrity of outcomes reported by the project.



Key Elements of an Evaluation Plan

Kinds of Evaluation

- **Formative** approaches that guide the project through its development and implementation, yielding suggestions for how the work might be improved.
 - *Internally* focused.
- **Summative** approaches that provide evidence to demonstrate whether the approach worked as intended.
 - *External* analysis.

Project Evaluation Personnel

- **Advisory Board:** Internal analysis; Formative advising, Especially appropriate for Exploratory and early-stage work.
- **External Evaluator:** Formative and summative analysis of project implementation and results; Strongly recommended for design & development studies.

- Resources available at the ITEST Resource Center website: <https://stelar.edc.org/search#evaluation>
- Additional resources at <https://www.informalscience.org/evaluation>



Key Elements of a Research Plan

- Research questions
 - appropriately framed and motivated by scholarly literatures
 - theory-oriented and enhance the ability to explain the relation between the proposal's design and the anticipated outcomes.
- Specific plans for collecting quantitative and/or qualitative data that can inform the research questions.
- Well-defined analytical methods appropriate for drawing inferences from the collected data to address all research questions.
- A description of the research team's roles and expertise.



Research Questions and Methods

- Research **questions**
 - Address significant issues or problems that are deeply rooted in one or more STEM fields;
 - Are clear, specific and can be investigated empirically;
 - Are grounded in theory;
 - Aim to advance and contribute to the field.
- Research **methods** should closely align with clear, specific research questions.
- **Coherence or alignment** among research questions and methods is one key characteristic of a competitive proposal.



Quantitative Research Plan

- **Should explicitly describe:**
 - Research design including underlying assumptions such as threats to internal and external validity (and bias) for experimental and quasi-experimental studies
 - Targeted population, sample size and sampling including estimates of effect sizes and power analysis
 - Measures and instruments for key constructs including information on the reliability, validity, and appropriateness of proposed measures and instruments or plans for establishing them if not initially known
 - Data analysis including descriptive, correlational/regression, inferential and/or structural modeling



Qualitative Research Plan

- **Should explicitly describe:**
 - Research Design that names a specific qualitative research approach (e.g., case study, ethnographic study) and explains why this approach aligns well with the research questions and data collected during the project
 - Contextual and demographic characteristics of participants and plans for recruitment that is aligned with the specific qualitative research approach
 - Description of instruments for data collection (e.g., interviews, surveys), the development or adaptation procedures for the instruments
 - Qualitative Analysis approaches including explanation of how codes and themes will be developed to respond to the research questions



EMERGING WORKFORCE PRIORITIES

- AI
- Data Science
- Computational Thinking
- Quantum Information Science and Engineering



Learning AI in K-12

Education and Workforce Development



AI Education vs AI-Augmented Education

AI Education:

- **Teaching and learning the concepts and principles of AI** in formal (schools) or informal (after school, public media, museums) contexts.
- **Professional training and development** of K-12 teachers and postsecondary faculty.
- **Workforce development** to prepare future and current workers in AI.

AI-Augmented Education:

- **Learning environments that employ AI-related techniques**, such as ML, computer vision, educational data mining, to support human learning through innovative intelligent learning technologies.
- Examples: ITS, conversational robots, adaptive personalized learning and AI-supported collaborative learning.



K-12 AI Education Proposals Need to Tackle Explicitly

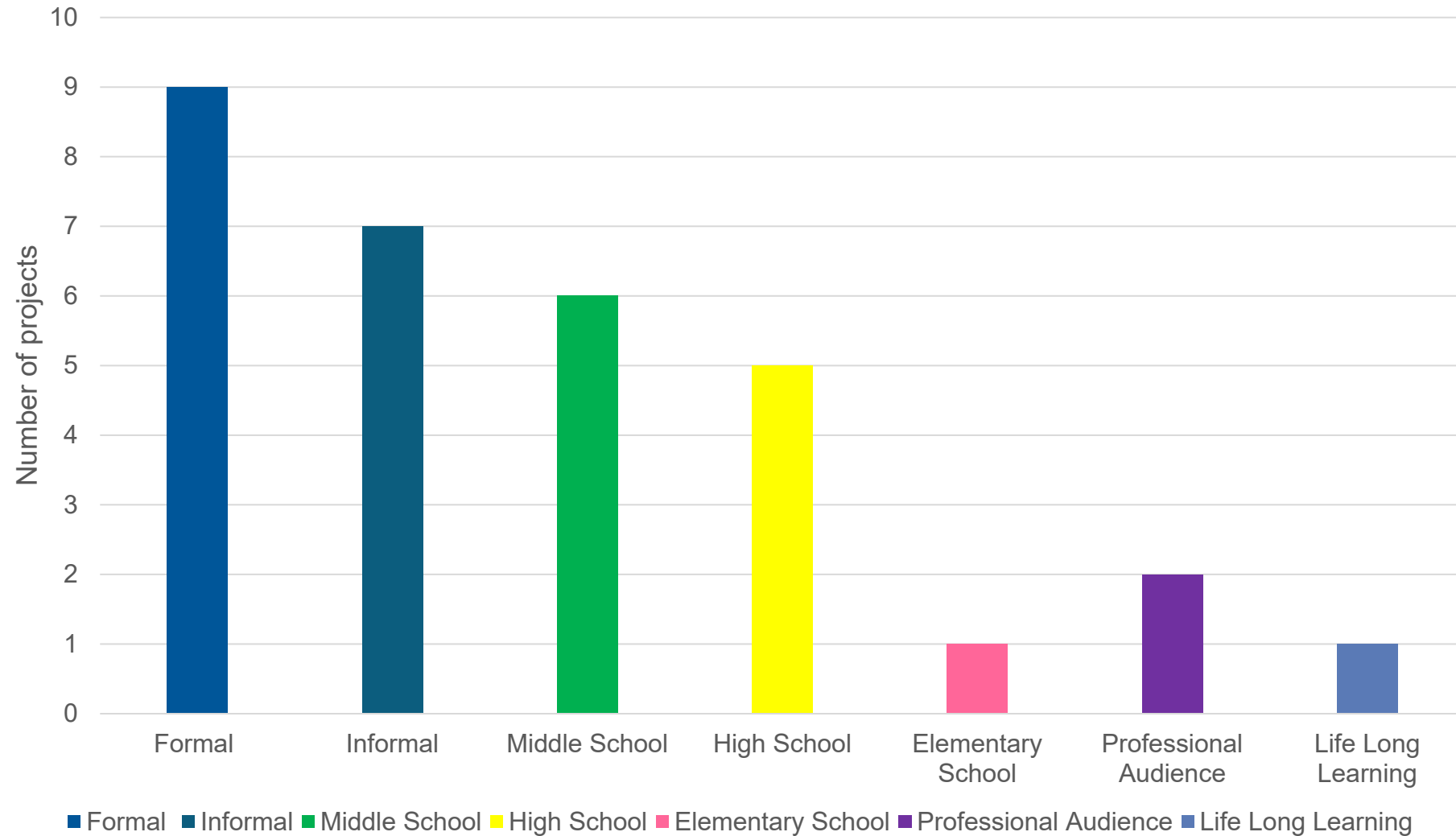
- Teaching AI in formal or informal settings, advancing our knowledge on K12 AI learning.
 - What **concrete AI concepts** will learners learn and what are the models of AI concepts for different grade bands/age groups?
 - What is the **nature of AI knowledge** learners are expected to acquire? What is the research design that will assess that AI knowledge and what are the measures?
 - How will learners learn the concepts? What is the **learning platform** and what are the **pedagogical innovations** to facilitate the learning of the AI concepts?



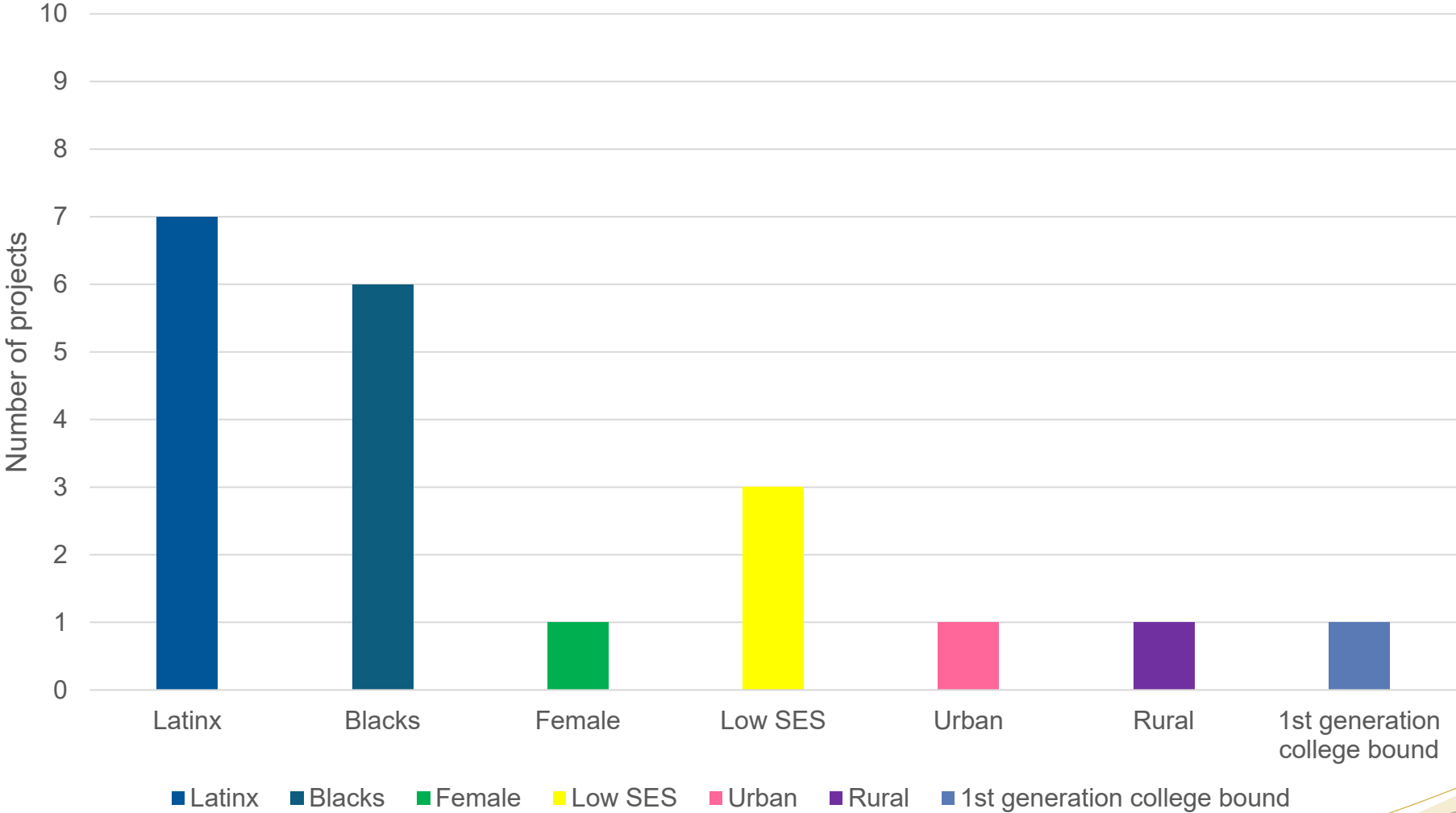
What has been funded so far.... (FY18-FY22)



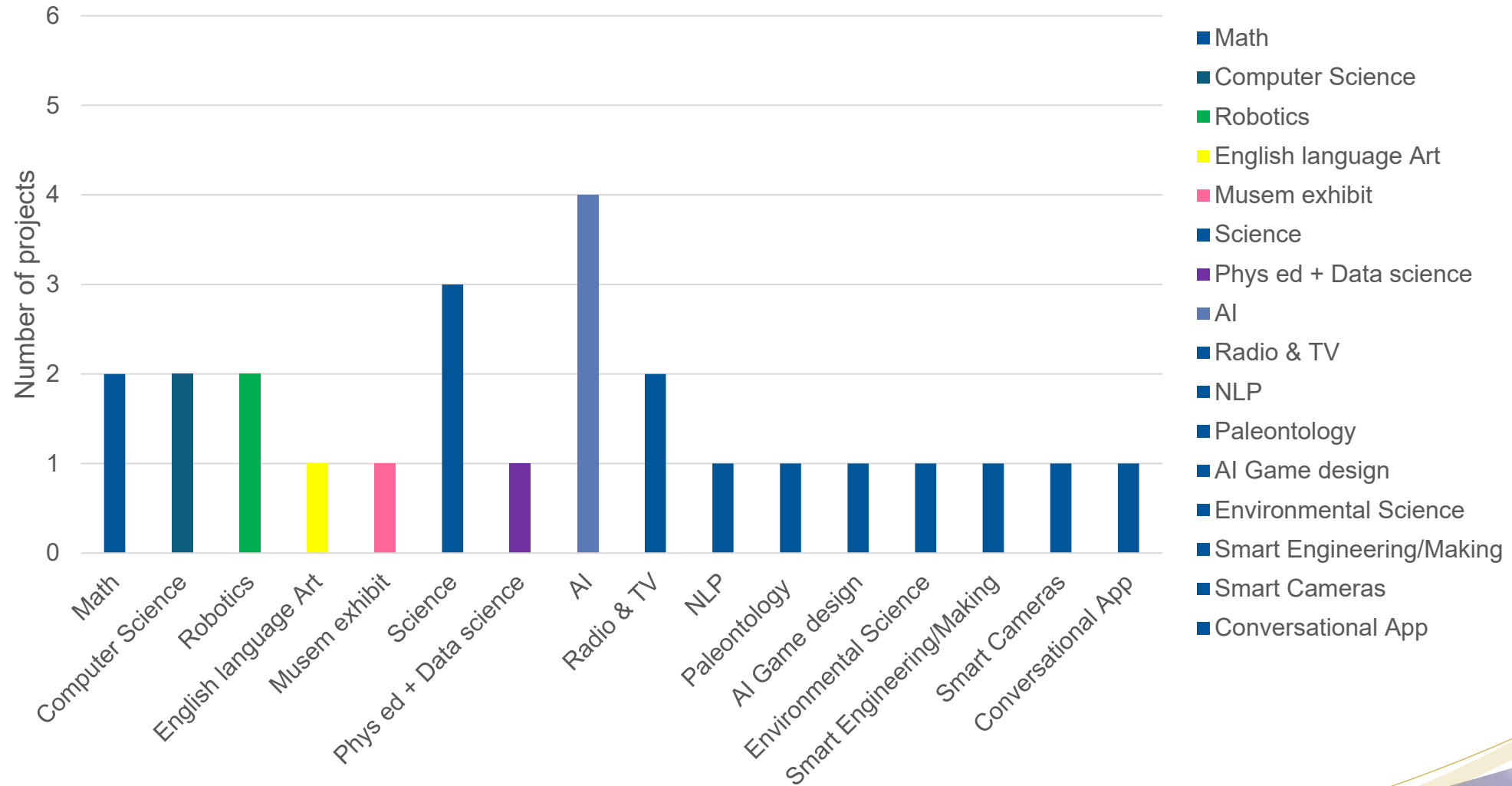
Learning Settings and Grade Bands



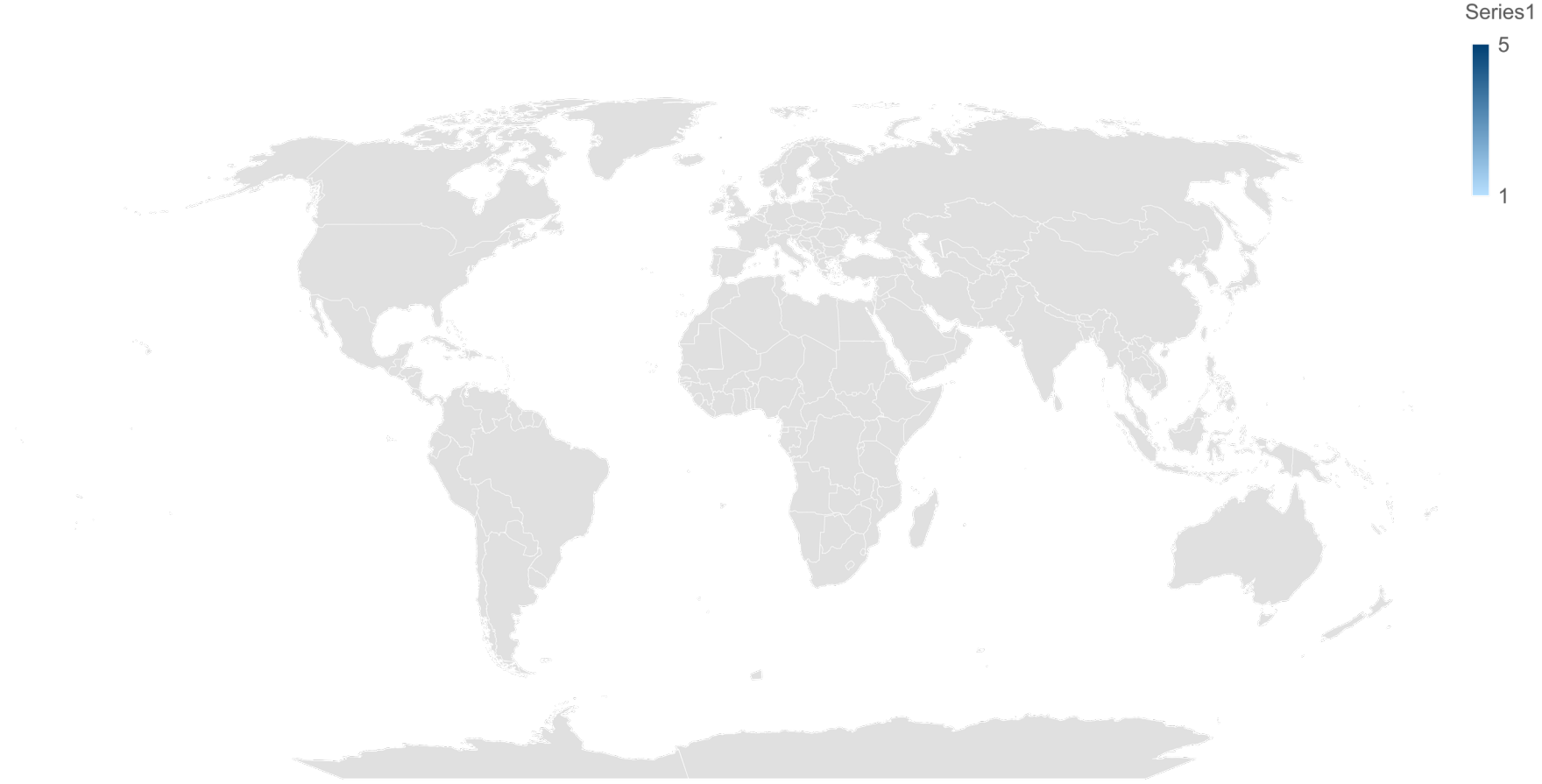
Learner Demographics



Subjects into which AI curriculum has been integrated



States with Funded Projects with AI-focus



© Australian Bureau of Statistics, GeoNames, Microsoft, Navinfo, OpenStreetMap, TomTom
Powered by Bing



Data Science



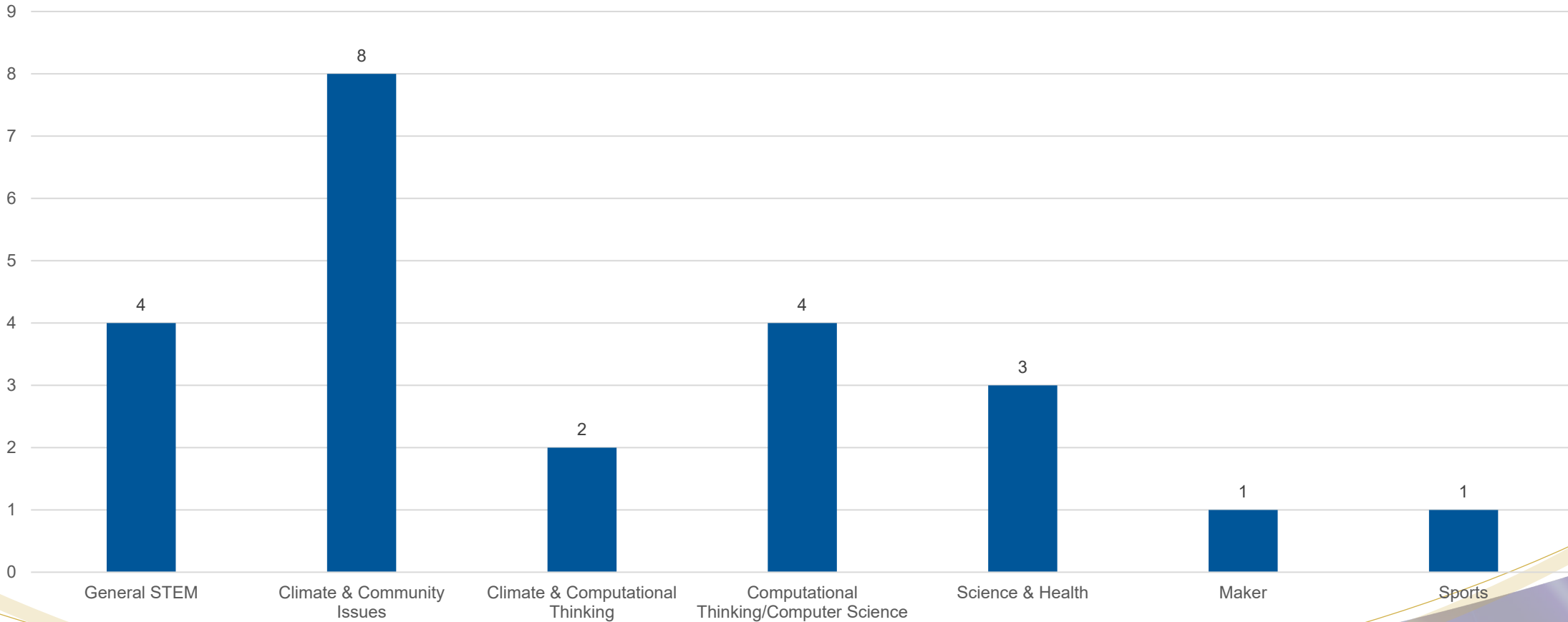
Data Science

- Very small percentage of awards have focused on data science
 - Only 23 Data Science Focused awards in the past 10 years
 - These awards tend to integrate at least one additional field of study
 - General STEM
 - Climate Science
 - Computational thinking/Computer science
 - Local community issues
 - Health
 - Sports
 - Maker spaces



Data Science Focused Awards Integrated with other Topics

Total Number of Data Science Focused Awards: 23



Data Science

- Permeates all aspects of modern life
- Inherently connected to all fields of study
- Essential for developing future workforce in STEM as well as data literate citizens
- Data science education has the power to combat misinformation while providing learners data-based understanding of issues that impact their personal lives & communities via data stories and data visualizations



Data Science Focused Proposals Should Explicitly Address:

- Context is key!
 - What other context(s)/topic areas will be integrated into the project?
 - Why this context for introducing data science?
- What key data science concepts will be introduced to learners and why?
- What age group is the project targeting and how are the data science concepts appropriate and important for the targeted age group?
- How will the technology innovation support the learning of the data science concepts for the targeted age groups?
- Why is the technology innovation pedagogically appropriate and important for facilitating the learning of the data science concepts?



Computational Thinking



Computational Thinking

- **Define Computational Thinking:** What are the focal computational thinking concepts and practices to be used?
 - Defined by, and operationalized from what framework or standards
 - Why does the definition chosen fit the learning challenge?
 - As CT has been traditionally defined by computer science, will PIs seek to determine new definitions of CT related to STEM learning/teaching?
- **If CT is integrated into STEM, define the STEM discipline(s):** What is the focal STEM content, concepts, and practices to be addressed?
- **Studying/measuring CT**
 - How will CT be objectively studied/measured?
 - Self-report surveys are generally not considered sufficient, if used as the only measures of teaching/learning
 - What field-advancing knowledge that would potentially be generated from a study of this approach to integration?

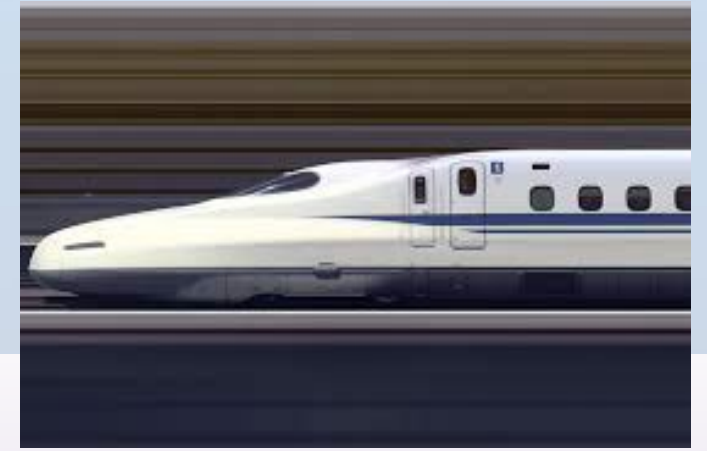


Quantum Information Science and Engineering Education and Workforce Development





All-of-Government Approach: WORKFORCE, EDUCATION AND BROADENING PARTICIPATION



Creating a quantum-smart workforce for tomorrow

Building Quantum Intuition: Quantum intuition is the ability to intuitively differentiate between quantum and classical worlds at the very basic level. **LOWERING THE BARRIERS**

Industry - academia partnerships: recognize required skills and nature of the content specific training that is needed for a diverse workforce. **EFFICIENCY**

Enhancing curricula in all levels of education: early and continued engagement in STEM fields, particularly for underrepresented groups in STEM such as underrepresented minorities and women, is a key factor in retaining and mitigating attrition as students advance to higher grade levels. **INCLUSION AS OPPORTUNITY**

Interdisciplinary programs: mathematical algorithms need to be devised, circuit implementations need to be designed, device function needs to be well understood, devices need to be implemented in functional materials, the local environment needs to be controlled, and structural materials are needed to hold everything together. **CONVERGENCE**

Estimating and tracking future workforce needs: continuing assessment of specific requirements for workforce is vital, especially in a rapidly evolving landscape of workforce needs. **ASSESSMENT**

Government Programs to enhance QIS-ready workforce: supportive of workforce generation goals, with focused efforts undertaken in collaborative mode **LEVERAGE**

Key Concepts for Future QIS Learners

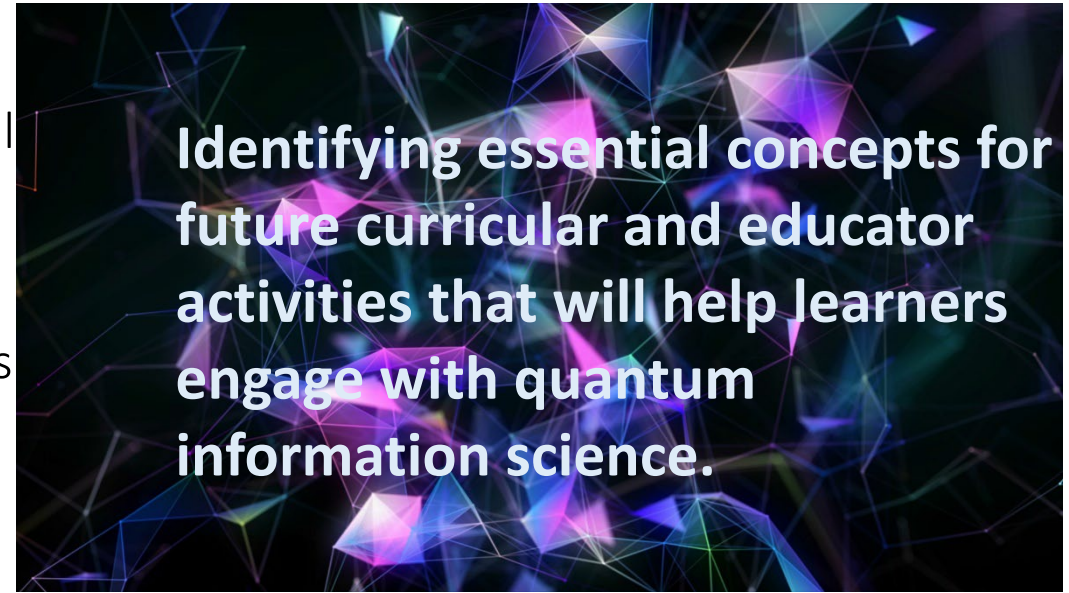


K-12

- Organized by NSF and OSTP
- Focused Workshop planned for March 25-26, turned virtual
- 30+ hours of online discussions: April, May, 2020
- report published online: May 13, 2020
- participants: group of university and industry researchers, secondary school and college educators, and representatives from educational and professional organizations

Nine Key Concepts for Future QIS Learners

1. **Quantum information science**
2. **Quantum state**
3. **Measurement**
4. **Quantum bit**
5. **Entanglement**
6. **Coherence**
7. **Quantum computers**
8. **Quantum communication**
9. **Quantum sensing**



Identifying essential concepts for future curricular and educator activities that will help learners engage with quantum information science.

Information about outcomes:

NSF public announcement:

https://www.nsf.gov/news/special_reports/announcements/051820.jsp

List of Key Concepts with Commentary and Feedback Form:

<https://qis-learners.research.illinois.edu/>

National Q-12 Education Partnership and Q2Work Program

The National Q-12 Education Partnership includes tech companies, scientific professional societies, academics, and the NSF-funded Q2Work Program. Together, we aim to support and grow a quantum workforce that is diverse and equitable, such that the QIS innovators of tomorrow can make discoveries, invent new technologies and drive societal change. We want to increase opportunities, access, and quality of age-appropriate QIS educational experiences for students from all backgrounds.



National Q-12 Education Partnership

Growing the Quantum Workforce.

The White House Office of Science and Technology Policy and the National Science Foundation are launching a partnership between the Federal government, industry, professional societies and the education community that will expand access to K-12 quantum learning tools and inspire the next generation of quantum leaders.

[Learn More](#)



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NSF public announcement:
https://www.nsf.gov/news/special_reports/announcements/080520.jsp

Program Homepage:
<https://q12education.org/>

K-12 QISE Education Proposals Need to Tackle Explicitly

- What specific quantum concepts and skills will learners learn? How will learners learn the quantum concepts and skills? Are the proposed learning or resources (e.g., tools, curriculums, learning activities) designed in a way that is developmentally and age-appropriate for students at different grade bands/age groups, particularly with students from underserved and underrepresented populations in STEM fields?
- What are the research questions? What is the research design that will assess that quantum knowledge/learning and what are the measures?
- What are the pedagogical innovations to facilitate the learning or teaching of the quantum concepts and skills? How will the proposed research advance our knowledge on K-12 QISE education and/or workforce development?



EXAMPLES OF QISE PROJECTS



K-12

- **#2015205** Cross-Discipline Approach to Quantum Computing in High Schools: Building towards a Quantum Computing Workforce, which focuses on three activities: summer workshops for teachers, building the community of educators involved in deployment of quantum content at schools and organizing a meeting of stakeholders.
- **#2009351** Preparing Secondary Teachers to Teach Quantum Information Science built around providing content and support for teachers to develop a sense of how quantum information science and technology affects their students, and how to support understanding of quantum concepts.
- **#2048691** Preparing Secondary Teachers and Students for Quantum Information Science will provide summer camps for students to learn about quantum, regardless of whether they take a physics class. This project will also provide opportunities for secondary educators to learn about QIS and practice teaching it.
- **#2115780/2115843** AIISL: Building Quantum Information Science Intuition through Digital Games will create a suite of accessible, engaging digital games for middle schoolers, and study their effectiveness in cultivating intuition around QIS.



Concluding Remarks

NSF Q&A Office Hours for the 2022 ITEST Solicitation

- The 3 ITEST Pillars and the Solicitation-Specific Criteria, 6/13 1pm ET.
- Project Types, 6/24 1pm ET.
- Budget, Data Management Plan, and Post-doctoral Mentoring Plan, 7/22 1pm ET

To register, please check the STELAR website at <https://stelar.edc.org/>



General inquiries regarding this program and program solicitation should be made to:

DRLITEST@nsf.gov

What should you do if you have a specific inquiry regarding your project or proposal?

Using the email address above, in the body of the email or as in attachment, send a brief (max 2 pages) summary of the research or R&D you are planning to conduct. The synopsis should include a very brief rationale for the work, how it will contribute to the knowledge base on informal learning, and what you believe the broader impacts to be. Be sure to also include your specific questions.



We look forward to receiving your proposals

Solicitation:

<https://www.nsf.gov/pubs/2022/nsf22585/nsf22585.pdf>

Full Proposal Deadline: August 12, 2022
(due by 5 p.m. submitter's local time):

