Assessment in STEM Classrooms: Insights for Researchers and Practitioners

Eric Wiebe, North Carolina State • **Christopher Harris,** WestEd • **James Pellegrino,** University of Illinois • **Erin Furtak,** U. of Colorado • **Shuchi Grover,** Looking Glass Ventures • **Seth Jones,** Middle Tennessee State University • **Okhee Lee,** New York University

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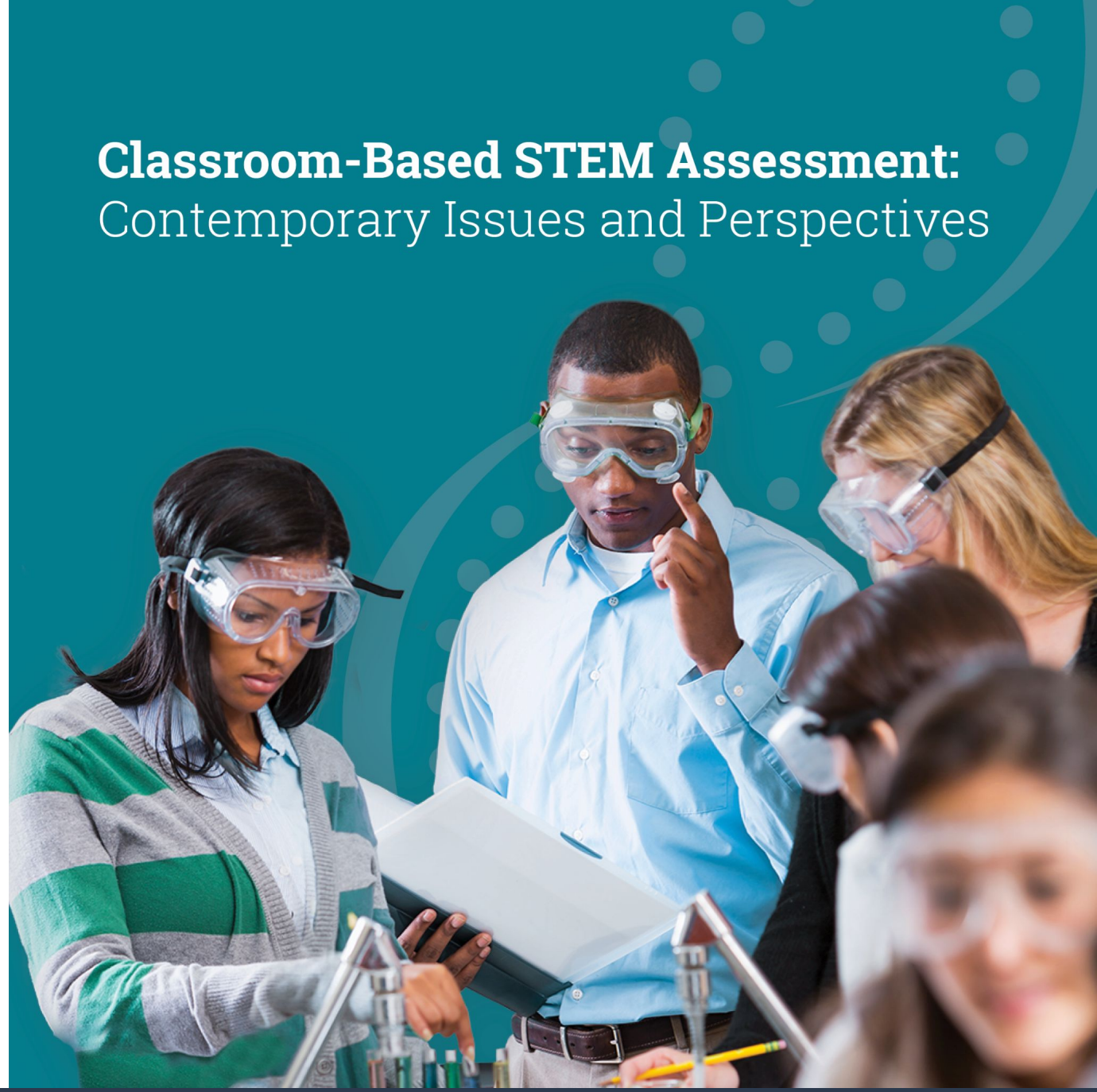
Session Overview

1. *Report Overview*
2. *Introduction to the Report*
3. *Recommendations from the Report*
4. *Discussion*
5. *Wrap-up*



Background on the Report

Classroom-based STEM Assessment: Contemporary Issues and Perspectives

- Driven by recent developments in classroom assessment R&D and the need to consider implications for STEM Education
- Working grouped formed to prepare a report on classroom-based assessment in STEM for multiple audiences:
  - ➢ Consider existing and emerging knowledge on the integration of assessment into classroom teaching and learning in the STEM disciplines
  - ➢ Chart a course for high priority areas
  - ➢ Audience includes CADRE members, NSF, and STEM education researchers, practitioners and policy makers

Report Authors

Steering Committee:

Shuchi Grover, Looking Glass Ventures

Christopher Harris, WestEd

James Pellegrino, University of Illinois at Chicago

Eric Wiebe, North Carolina State University

Working Group:

Eric Banilower, Horizon Research

Arthur Baroody, University of Illinois Urbana-Champaign

Erin Furtak, University of Colorado Boulder

Leanne Ketterlin-Geller, Southern Methodist University

Seth Jones, Middle Tennessee State University

Okhee Lee, New York University

Xiaoming Zhai, University of Georgia

Five Topical Sections

Section 1. ***Connecting Classroom Assessment with Curriculum and Instruction through Theories of Learning***

Leanne Ketterlin-Geller, Southern Methodist University • Christopher Harris, WestEd

Section 2. ***Assessment For Learning***

Arthur Baroody, University of Illinois Urbana-Champaign •
James Pellegrino, University of Illinois at Chicago

Section 3. ***Equity and Justice in Classroom Assessment of STEM Learning***

Erin Furtak, University of Colorado Boulder • Okhee Lee, New York University

Section 4. ***Teachers' Knowledge and Practices for Assessment***

Seth Jones, Middle Tennessee State University •
Eric Banilower, Horizon Research • Shuchi Grover, Looking Glass Ventures

Section 5. ***Technology-based Innovative Assessment***

Xiaoming Zhai, University of Georgia • Eric Wiebe, North Carolina State University

Introduction to the Report

Jim Pellegrino, University of Illinois Chicago • **Shuchi Grover**, Looking Glass Ventures • **Christopher Harris,** WestEd • **Eric Wiebe,** North Carolina State University

Why this Report?

Multiple research and policy developments over the last two decades support the potential value of such a report:

1. The changing landscape of policy and practice discussions regarding desired outcomes from the educational system for the 21st century
2. Related changes in the content standards and student outcomes expected in the STEM disciplines
3. Explications of the science underlying design of educational assessments to support their varying forms and functions in the educational system
4. Evolution of theory and research on the nature and development of STEM disciplinary learning and its implications for classroom instruction and assessment

Why this Report? (cont)

5. A shift from emphasis on large-scale standardized testing to greater focus on the uses of assessment in the classroom as part of ongoing teaching and learning.

Two major societal developments:

1. Increased urgency to address long-standing disparities in opportunities to learn and educational outcomes for underserved and marginalized populations
2. Rapid growth of student access to technologies and the development of potent computational tools, such as data analytics and AI, to support the integration of classroom assessment into instructional practices, including enactment of formative assessment practices.

Intended Audiences and Purposes

Audience

Members of the CADRE community, Program Directors and Project Officers at the National Science Foundation, and STEM education practitioners and policy makers.

Help accomplish two things:

1. Stimulate dialogue among members of these communities to enhance implementation of effective assessment practices in K-12 STEM education classrooms, as well as impact in-service and pre-service teacher professional learning programs.
2. Chart a course for high priority areas for the next decade for STEM classroom assessment research, development, and implementation to be funded by NSF, other federal agencies, and private foundations.

Six Major Developments with Implications for Classroom Assessment R&D

1. *Standards and expectations for STEM Proficiency have changed substantially and now demand integrated knowledge of core disciplinary knowledge and practices. The new standards have major implications for design and implementation of curriculum, instruction, and assessment.*

2. *Theories, models, and data on disciplinary knowing and learning have changed substantially and are best represented by a broad sociocultural perspective on the general nature of knowing and learning combined with theory and research on discipline-specific learning progressions.*

3. *Coordination and integration of curriculum, instruction, and assessment is essential to achieve coherent classroom learning environments and best achieved when all three are derived from conceptual models and empirical data on disciplinary knowing and learning.*

Six Major Developments with Implications for Classroom Assessment R&D (cont)

4. *Assessment is a process of reasoning from evidence represented by the three interconnected elements of Cognition, Observation, and Interpretation. Critical to the validity of this 'reasoning from evidence' process are conceptual models and empirical data on disciplinary knowing and learning.*

5. *Classroom practice requires differentiating formative from summative functions of assessment and the ability to implement these practices accordingly. Formative assessment can significantly impact student learning outcomes but doing so hinges on multiple facets of teachers' assessment literacy knowledge, as well as the availability of tools that teachers can use to support valid and appropriate formative and summative practices.*

6. *The affordances of technology to support classroom assessment have greatly increased, including interactive and adaptive stimulus materials, response data capture, and application of data analytic and computational interpretive tools. Considerable work remains to be done to effectively integrate these developments into classroom instructional practice.*

Five Topical Sections

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Section 4. ***Teachers' Knowledge and Practices for Assessment***

Seth Jones, Middle Tennessee State University •
Eric Banilower, Horizon Research • Shuchi Grover, Looking Glass Ventures

Section 5. ***Technology-based Innovative Assessment***

Xiaoming Zhai, University of Georgia • Eric Wiebe, North Carolina State University

Why These Five Topical Sections?

- Decision making about Section Topics was guided by a collective sense of substantial bodies of work that have accrued on critical issues in the integration of assessment into classroom teaching and learning in the STEM disciplines
- Each Topical area has major implications for current practice as well as future research and development.
- Each Topical Synthesis should be highly productive for stimulating dialogue and future work, in part because it integrates knowledge across several of the developments mentioned previously.
- Collectively, the five Topical Syntheses cover all six developments while representing different and important integrations and perspectives on the knowledge and practice of STEM classroom assessment.
- The Introduction to the Report provides brief summaries of major points from each Section
- The Introduction also provides brief summaries of relevant R&D providing the warrants for the six claims regarding developments impacting STEM classroom assessment

Coda

- Effective use of assessment in the STEM classroom to support student learning is more complex and challenging than one might otherwise assume it to be.
- It requires the synthesis and integration of multiple areas of theory and research regarding the knowledge to be assessed, teacher knowledge and practice, the complex ecology of the classroom, and resources and tools for implementation and management.
- The five Sections of the report provide multiple perspectives on what has been learned to date for each of these various topics, including their integration, while simultaneously identifying directions for much needed future research and development.
- The concluding Section of the Report provides a summary of recommendations emerging from each Section along with an overall set of implications for research, practice, and policy.

Recommendations from the Report

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Section 1. *Connecting Classroom Assessment with Curriculum and Instruction through Theories of Learning*

Leanne Ketterlin-Geller, Southern Methodist University • Christopher Harris, WestEd

This section emphasizes the importance of aligning classroom assessments with STEM learning goals and instruction so that they can be used as part of ongoing instruction to monitor students' progress in learning and to support future learning.

Learning Progressions / Learning Trajectories

- Describe how students develop greater sophistication in disciplinary topics; derive from a knowledge base about how learning builds in a domain over time
- Offer a compelling and principled way for developing classroom-based assessments
- Stand to provide insight into how students' disciplinary knowledge and practices are developing over time with appropriate instruction.

Section 1. *Connecting Classroom Assessment with Curriculum and Instruction through Theories of Learning*

Leanne Ketterlin-Geller, Southern Methodist University • Christopher Harris, WestEd

Recommendations:

- Standards and expectations for STEM proficiency have changed substantially and assessments for today's STEM classrooms should reflect these contemporary perspectives on learning in the disciplines.
- As learning progressions/trajectories continue to be mapped out and empirically validated in the STEM disciplines, it will be important to focus research efforts on their use as a framework for developing and using assessments that inform instructional decision-making.
- More research work is needed to help us better understand the ways teachers can generate meaning from assessment results that will transform students' opportunities to learn.

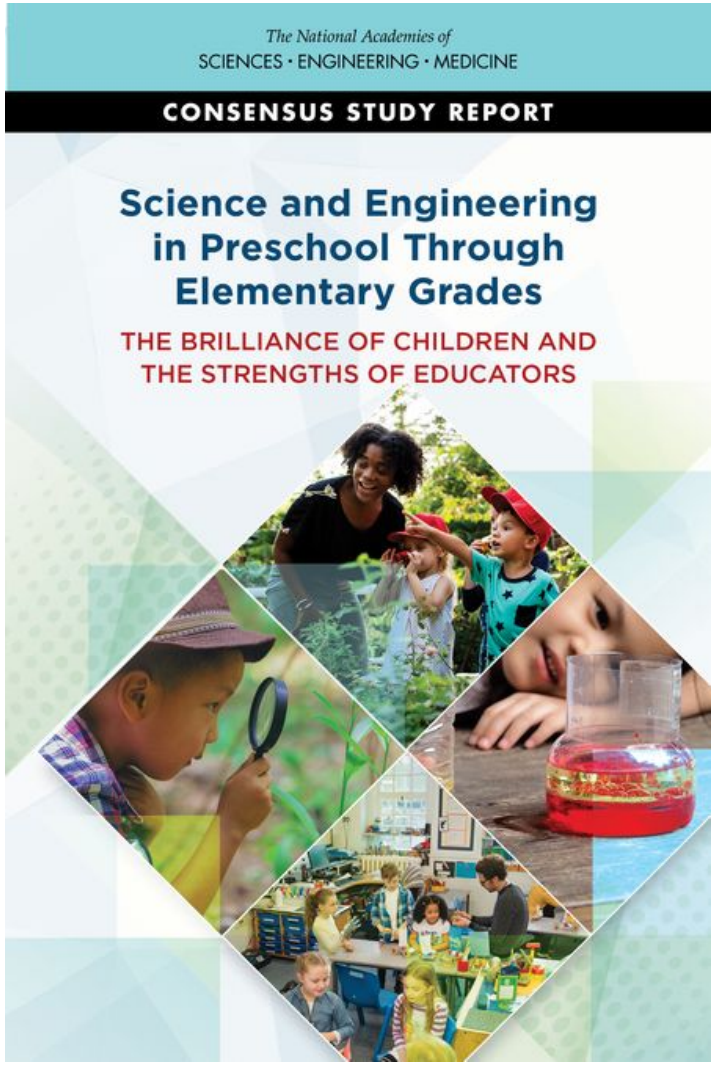
Section 2. *Assessment For Learning*

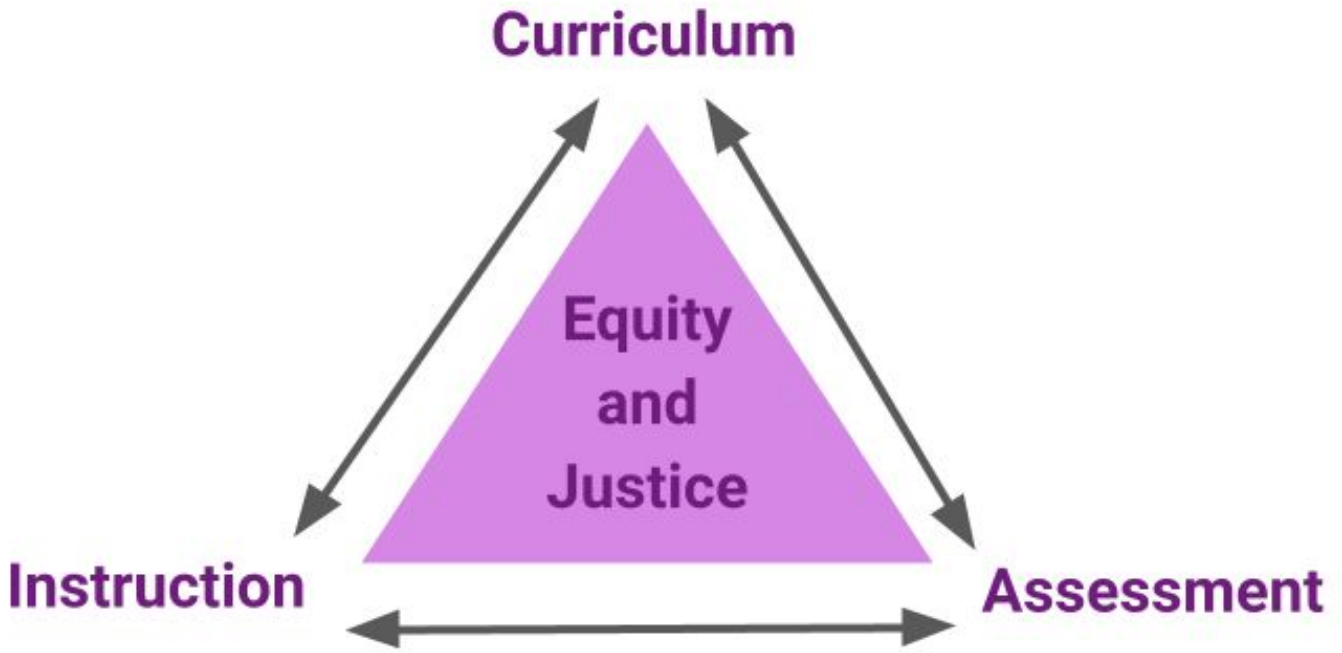
Arthur Baroody, University of Illinois Urbana-Champaign
James Pellegrino, University of Illinois at Chicago

- There is a deep research base that can be applied to understand formative assessment for learning
- High quality assessment development and validation work is needed for classroom-based STEM assessments that can be used to improve teaching and advance learning.
- Ongoing research is needed about the nature and efficacy of professional learning for supporting teachers to implement formative assessment effectively.
- Development, iterative refinement, and validation of learning progressions across all the STEM disciplines should continue and is especially encouraged in emerging areas of technology, engineering, and computer science education.

Section 3. *Equity and Justice in Classroom Assessment of STEM Learning*

Erin Furtak, University of Colorado Boulder • Okhee Lee, New York University



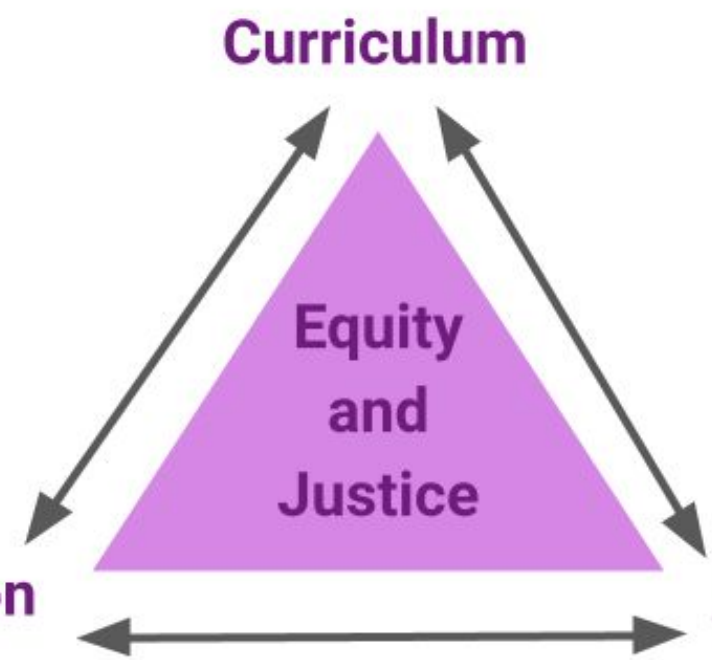


Equity: Broadening access and increasing achievement and representation in STEM

Justice: Expanding what constitutes STEM and seeing STEM as part of justice movements

Equity: Curriculum materials centered on phenomena and problems that are authentic and relevant to learners' lives

Justice: Curriculum materials developed in partnership with families and communities using phenomena and problems located in place



Equity: Expansive space for students to share their thinking and ways in which they demonstrate their learning, and for teachers to be responsive to their ideas

Equity: Transformative approaches based in communities and places. Assessment tasks center and create space for students' cultural practices and knowledge; 'baked-in' designs to increase accessibility

Justice: Space for teachers to reflect on their own experiences, histories, and connections to place in professional learning

Justice: Transformative approaches based in communities and places; acknowledge multiple ways of knowing, engagement, representation, action and expression

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Erin Furtak, University of Colorado Boulder • Okhee Lee, New York University

- As curriculum and instruction shift to center equity and justice, assessment must also change so that equity and justice are placed at the center of assessment of STEM learning and all three major components of the learning environment can work effectively together.
- Contemporary perspectives of equity and justice should be central in STEM classroom assessment design and practice.
- The DRK-12 program should take a more expansive view of assessment as integral to curriculum and instruction and consider that all three must work together toward new futures in STEM learning.
- In the development of assessments that center equity and justice, designers should build assessments in concert with educators, learners, and communities.
- Assessment work should embrace a wider and more inclusive view of what constitutes historically minoritized populations.

Section 4. *Teachers' Knowledge and Practices for Assessment*

Seth Jones, Middle Tennessee State University •
Eric Banilower, Horizon Research • Shuchi Grover, Looking Glass Ventures

- The promise of classroom-based STEM assessment rests on the extent to which teachers understand the formative use of assessment and can incorporate it into their instructional practice.
- New assessment development projects should attend to the knowledge and practices teachers need support in and design assessment systems to support professional learning and uptake in practice.
- Recommendations:
  - Empirically based and disciplinary specific cognitive models of students thinking
  - Feasible tools and strategies to elicit evidence of thinking
  - Tools to support the interpretation of student thinking
  - Learning opportunities to develop equitable assessment practices
  - Support to make use of appropriate technologies to support assessment practices

Section 5. *Technology-based Innovative Assessment*

Xiaoming Zhai, University of Georgia • Eric Wiebe, North Carolina State University

- Recent progress in a range of areas including artificial intelligence (AI), real-time assessment, digital technologies, and virtual reality combined with new techniques from measurement science and data analytics are playing critical roles in enabling innovative assessment practice.
- R&D work should continue to explore how technology can support and improve the effectiveness, equity, and feasibility of complex STEM teaching and learning.
- Cross-disciplinary teams of experts are needed for envisioning, designing, and ensuring the development of AI-driven classroom-based assessment systems that benefit students and teachers.
- Research is needed on the distribution and operationalization of real-time assessment data–to whom (teachers, students, both), at what time frame, and what form.

Questions?

Classroom-Based STEM Assessment:
Contemporary Issues and Perspectives

Thank You!

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  https://cadrek12.org/sites/default/files/2023-08/Classroom-Based%20STEM%20Assessment%20FULL%20REPORT.pdf
- **Executive Summary Download:**
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