Mathematics Evidence-Based Practices Brief

What are evidence-based practices?

Evidence-based practices are instructional strategies and approaches grounded in rigorous research and demonstrated to improve student learning outcomes. They rely on data from well-designed studies to solidify whether a practice is effective, rather than intuition. Using evidence-based practices means intentionally selecting methods that have been shown to be effective, implementing those practices with fidelity, and continuously monitoring student learning so adjustments can be made if needed.

The Every Student Succeeds Act (ESSA) references tiers of evidence, which provides districts and schools with a framework for determining which programs, practices, strategies, and interventions work in which contexts and for which students. This handout, ESSA Tiers of Evidence (REL Midwest, 2019), provides additional information about the ESSA tiers of evidence and the kinds of studies necessary to determine those evidence tiers.

Why is the use of evidence-based practices important?

The use of evidence-based practices is essential not only for classroom instruction but also for improved student learning, as it ensures that the teaching methods used are proven to support student learning rather than relying on trial and error. When educators use practices and strategies grounded in high-quality research, they are more likely to meet students' diverse needs, reduce achievement gaps, and use instructional time effectively.

Introduction

Effective mathematics teaching is far more than the content standards and standards for mathematical practices alone. Helping students learn mathematics in Iowa means using effective teaching strategies and valuing who students are, how they learn, and the ways they make sense of mathematics. This brief connects research with practice. Specific, research-based teaching practices that are essential for a high-quality mathematics education for every student are combined with core principles to build a successful mathematics program at all levels. These strategies help teachers engage students in mathematical thinking, reasoning, and sense-making, thereby significantly strengthening teaching and learning. The following practices are effective for all learners as part of universal instruction; advanced learners, students with disabilities, and multilingual learners may benefit from additional support based on their individual programming needs.

Highlighted practices include, but are not limited to:

- Promoting Positive Math Confidence and Engagement
- High Quality Instructional Materials aligned to the Math Shifts
- Establish Mathematics Goals to Focus Learning
- Implement Tasks that Promote Reasoning and Problem Solving
- Use and Connect Mathematical Representations
- Facilitate Meaningful Mathematical Discourse
- Pose Purposeful Questions
- Build Procedural Fluency from Conceptual Understanding
- Support Productive Struggle in Learning Mathematics
- Elicit and Use Evidence of Student Thinking

Listed resources are examples intended to support educator understanding and implementation and are not intended as an endorsement of a specific program or product.

Practice: Promoting Positive Math Confidence and Engagement

Overview

Effective mathematics teaching promotes positive math confidence and engagement. (*Principles to Actions, 10th Anniversary*, 2024)

What are teachers doing?	What are students doing?
• Encouraging all students to see themselves as confident and capable problem solvers • Finding ways to connect to students' lived experiences and cultures • Normalizing mistakes as part of the learning process • Focusing student feedback on sense-making and perseverance rather than the correctness • Positioning all students to be sources of expertise and emphasizing student-to-student interactions • Utilizing tasks that provide multiple entry points and solution pathways that engage students with varying skills to make valuable contributions • Showcasing mathematics through classroom newsletters and frequent communication with families to stay informed on mathematics activities and student successes	• Sharing their reasoning and thinking during whole-class, small-group, and pair-share discussions • Encouraging peers by celebrating successes and respectfully challenging when they disagree • Using personal experiences and cultural connections to make sense of problems • Taking risks by trying new strategies • Recognizing mistakes is expected and respected as part of learning • Setting goals for their own mathematical journey and reflecting on what actions help them achieve their goals

Resources to Support Educator Understanding

- Productive Beliefs about Teaching, (*Principles to Actions, 10th Anniversary*, 2024, p. 12)
- Classroom Practices to Promote a Positive Math Confidence and Engagement (REL Appalachia, 2022)
- Principles to Actions Toolkit* (NCTM, 2014)
- NCTM's Catalyzing Change (NCTM, 2018)

Tools to Support Implementation

- YouCubed Week of Inspirational Math (YouCubed, n.d.)
- YouCubed Growth Mindsets (YouCubed, n.d.)

* Indicates which modules within the link are open access without being an NCTM member.

Practice: High Quality Instructional Materials Aligned to the Math Shifts

Overview

Effective mathematics teaching promotes access to high-quality instructional materials aligned to the mathematical shifts of Focus, Coherence, and Rigor. (*Iowa Academic Standards for Mathematics 2024*)

What are teachers doing?	What are students doing?
• Collaborating with colleagues on selecting and implementing a curriculum that aligns with the major work of the grade • Utilizing standards-aligned lessons that balance the aspects of rigor (conceptual understanding, procedural skill and fluency, and application) • Adapting and improving tasks so they are relevant and accessible for students without removing cognitive demand • Trusting the materials to craft a coherent story across units and grade levels, and engaging in vertical alignment conversations • Using the provided educator supports to meet diverse learner needs (ex. discourse prompts, language routines, sample questioning and scaffolds) • Engaging in data-driven conversations in order to adjust pacing and scaffolds (ex. Analyzing student work)	• Engaging in rich, grade-level tasks that promote sense-making and discourse • Using the materials and advocating if they don't have the support needed to succeed • Making their thinking visible with the use of models and representations • Connecting ideas across units, other classes, and their lived experiences

Resources to Support Educator Understanding

- Iowa Academic Standards for Mathematics (Iowa Department of Education, 2024)
- Iowa Academic Standards for Mathematics Guidebook (Iowa Department of Education, 2024)
- Why Materials Matter (EdReports, n.d.)
- HQIM Adoption Steps (EdReports, n.d.)
- EdReports (EdReports, n.d.)
- Curriculum Materials Matter: Evaluating the Evaluation Process (Curriculum Materials Matter: Evaluating the Evaluation Process, 2014)
- Instructional Coherence (TNTP, 2022)
- Coherence Map (Achieve the Core, n.d.)
- Learning Trajectories Birth - Grade 3 (Learning & Teaching with Learning Trajectories, n.d.)

Practice: Establish Mathematics Goals to Focus Learning

Overview

"Effective teaching of mathematics establishes clear goals for the mathematics that students are learning, situates goals within learning progressions, and uses the goals to guide instructional decisions." (*Principles to Actions,10th Anniversary*, 2024, p. 12)

What are teachers doing?	What are students doing?
• Establishing goals that surface the deep mathematical connections that go beyond procedures • Identifying how the learning goal fits within the larger mathematical progression of a unit, year, discipline, or grade band • Maintaining that goals serve as the guideposts for selecting tasks, asking questions, and facilitating discourse • Explicitly referencing the goal with students throughout the entire lesson • Reflecting on the learning goal when deciding to make in-the-moment instructional decisions	• Connecting classroom activities and conversations to the goal (ex. What are we learning? Why are we learning it?) • Monitoring their own understanding and progress towards the learning goal • Using the learning goal to stay focused on the deep mathematical connections • Reflecting on where the learning goal connects with their prior experiences and knowledge

Resources to Support Educator Understanding

- Effective Teaching Practices PtA Overview,(slides 17-18) (*Principles to Actions*, *10th Anniversary*, 2024)
- Effective Teaching Practices Toolkit* (NCTM, 2014)

Practice: Implement Tasks that Promote Reasoning and Problem Solving

Overview

"Effective teaching of mathematics establishes clear goals for the mathematics that students are learning, situates goals within learning progressions, and uses the goals to guide instructional decisions." (*Principles to Actions,10th Anniversary*, 2024, p. 12)

What are teachers doing?	What are students doing?
• Selecting tasks that provide multiple entry points and promote access for all students in the classroom • Ensuring the task uses concise and inviting language or includes visuals • Adapting tasks so they are relevant, authentic, and/ or ignite creativity for students • Posing questions throughout the task that help or offer strategies, but not solutions • Encouraging students throughout the task to try different approaches, persevere, and build on their mathematical understanding	• Persevering and engaging in productive struggle • Supporting themselves and classmates by asking questions and justifying their thinking • Acknowledging that classmates will often use different approaches and leveraging different ways of thinking to strengthen their own understanding • Using tools and representations to make their thinking visible

* Indicates which modules within the link are open access without being an NCTM member.

Resources to Support Educator Understanding

- Effective Teaching Practices PtA Overview, (slides 19-20) (Principles to Actions,10th Anniversary, 2024)
- Effective Teaching Practices Toolkit* (NCTM, 2014)
- Characteristics of Levels of Demands (*Principles to Actions,10th Anniversary*, 2024, p. 18)
- Levels of Demands Sample Task (*Principles to Actions,10th Anniversary*, 2024, p. 19)
- NCTM Pay It Forward slide-deck (NCTM, n.d.)

Tools to Support Implementation

- Problem Solving Tasks: You Cubed (YouCubed, n.d.)
- Esti-Mysteries (Steve Wyborney, n.d.)

Practice: Use and Connect Mathematical Representations

Overview

"Effective teaching of mathematics engages students in making connections among mathematical representations to deepen understanding of mathematics concepts and procedures, and as tools for problem solving." (*Principles to Actions,10th Anniversary*, 2024, p. 24)

What are teachers doing?	What are students doing?
• Using tasks that provide an opportunity for multiple representations to be used • Encouraging students to make math drawings and concept maps to justify their reasoning • Introducing new forms of representations that students might be unfamiliar with • Allocating time to discuss different representations, encouraging students to focus on the structure and features that spotlight the math connections • Designing assessments that provide flexibility for students to use different representations	• Using representations that make meaning for themselves and encourage a deeper understanding of mathematics • Describing their drawings, diagrams, equations, graphs, and other representations for classmates • Considering which representation might be most effective for different types of problems • Mathematizing real-world situations by connecting to mathematical ideas

Resources to Support Educator Understanding

- Effective Teaching Practices PtA Overview, (slides 21-22) (*Principles to Actions, 10th Anniversary*, 2024)
- Effective Teaching Practices Toolkit* (NCTM, 2014)
- Important connections among mathematical representations, visual (NCTM, 2014)
- NCTM Use and Connect Mathematical Representations, slide deck (NCTM, n.d.)

* Indicates which modules within the link are open access without being an NCTM member.
* Indicates which modules within the link are open access without being an NCTM member.

Tools to Support Implementation

- Fostering Math Practices: Connecting Representations, videos (Fostering Math Practices, n.d.)

Practice: Facilitate Meaningful Mathematical Discourse

Overview

Effective teaching of mathematics facilitates discourse among students to build a shared understanding of mathematical ideas by analyzing and comparing student approaches and arguments. (*Principles to Actions,10th Anniversary*, 2024, p. 29)

What are teachers doing?	What are students doing?
• Positing students as creators of ideas who can explain and defend their strategies • Strategically selecting and sequencing student work for whole-class analysis • Recognizing discourse is not only verbally exchanging ideas, but also considering any form of communication that facilitates sense-making • Providing prompts and scaffolds to students who may need support with academic discourse • Supervising group work and ensuring student-to-student exchanges are supportive and focused • Directing the discourse to stay centered on the learning goal	• Sharing their ideas with classmates in pairs, small groups, and whole-class discourse • Using mathematical language and vocabulary • Prompting peers to add to the conversation and further participation • Listening carefully to peers and seeking to understand • Seeking to understand peers by asking clarifying questions, trying someone else's strategy, and paraphrasing approaches • Thinking about ways to use examples and counterexamples to defend or refute ideas • Comparing how different methods are alike and different

Resources to Support Educator Understanding

- Effective Teaching Practices PtA Overview, (slides 23-24) (*Principles to Actions, 10th Anniversary*, 2024)
- Effective Teaching Practices Toolkit* (NCTM, 2014)
- Levels of Classroom Discourse, slide-deck (NCTM, n.d.)
- Levels of Classroom Discourse rubric (*Principles to Actions,10th Anniversary*, 2024, p. 32)
- Mathematical Language Routines (Stanford, 2017)

Tools to Support Implementation

- Sentence Frames (Iowa Department of Education, n.d.)

* Indicates which modules within the link are open access without being an NCTM member.

Practice: Pose Purposeful Questions

Overview

"Effective teaching of mathematics uses purposeful questions to assess and advance students' reasoning and sense making about important mathematical ideas and relationships." (*Principles to Actions,10th Anniversary*, 2024, p. 35)

What are teachers doing?	What are students doing?
• Thoughtfully planning questions in advance to use during tasks and lessons • Asking advancing questions that encourage a shift in perspective but do not take over student thinking • Balance the use of questions that gather information, that probe thinking, that make the mathematics visible, and that encourage reflection and justification • Using sufficient wait time and strategies that allow all students to engage • Gathering data on their use of questions, reflecting, and engaging in coaching conversations to improve their questioning skills	• Being prepared to explain, clarify, defend, or elaborate on their thinking • Pausing for themselves and others to thoughtfully present questions and ideas • Listening to classmates' contributions and asking clarifying questions

Resources to Support Educator Understanding

- Effective Teaching Practices PtA Overview, (slides 25-26) (*Principles to Actions, 10th Anniversary*, 2024)
- Effective Teaching Practices Toolkit* (NCTM, 2014)
- PtA Types of Questions chart (*Principles to Actions,10th Anniversary*, 2024, p. 36-7)
- Posing Purposeful Questions, slide-deck (NCTM, 2015)

Practice: Build Procedural Fluency from Conceptual Understanding

Overview

"Effective teaching of mathematics builds fluency with procedures on a foundation of conceptual understanding so that students, over time, become skillful in using procedures flexibly as they solve contextual and mathematical problems." (*Principles to Actions,10th Anniversary*, 2024, p. 42)

What are teachers doing?	What are students doing?
• Selecting and sequencing tasks that build on students' prior knowledge, which progress to more efficient and formal methods	• Using and connecting a variety of representations and strategies to build an understanding of procedures

* Indicates which modules within the link are open access without being an NCTM member.

What are teachers doing?	What are students doing?
• Providing opportunities for students to generate their own strategies and methods to solve problems • Encouraging students to discuss why procedures are used to solve particular problems • Recognizing that strong mathematical conceptual understanding and procedural fluency build connected and over time • Providing meaningful distributed practice that is purposeful	• Engaging in meaningful distributed practice of procedures • Determine when patterns can be generalized or if they are unique to certain situations • Questioning themselves and others about why procedures work the way they do • Demonstrating flexibility with different strategies

Resources to Support Educator Understanding

- Effective Teaching Practices PtA Overview, (slides 27-28) (*Principles to Actions, 10th Anniversary*, 2024)
- Effective Teaching Practices Toolkit* (NCTM, 2014)
- Procedural Fluency in Mathematics, Position Statement (NCTM, 2023)

Practice: Support Productive Struggle in Learning Mathematics

Overview

"Effective teaching of mathematics consistently provides students, individually and collectively, with opportunities and support to engage in productive struggle as they grapple with mathematical ideas and relationships." (*Principles to Actions,10th Anniversary*, 2024, p. 48)

What are teachers doing?	What are students doing?
• Anticipating misconceptions that students might have and preparing a plan for how to respond in the moment • Prioritizing effort and perseverance in feedback rather than correctness • Providing opportunities for students to experience what mathematicians do • Establishing that speed is not as important as clarity and understanding • Developing an academically safe environment for students to be willing to make mistakes • Giving time for students to grapple with challenging tasks • Giving hints that increase access rather than decrease challenge	• Persevering through challenging tasks • Asking for help and helping one another without jumping right to the answer or how to solve a problem • Acknowledging when a strategy isn't working and being willing to try something else • Asking questions about understanding the problem before asking questions about how to solve the problem • Developing a growth mindset (ex, "I don't know how to do this yet, but I'm not giving up.")

* Indicates which modules within the link are open access without being an NCTM member.

Resources to Support Educator Understanding

- Effective Teaching Practices PtA Overview, (slides 29-30) (*Principles to Actions, 10th Anniversary*, 2024)
- Effective Teaching Practices Toolkit* (NCTM, 2014)
- Supporting Productive Struggle, slide-deck (NCTM, n.d.)
- Rich Tasks and Productive Struggle, slide-deck (NCTM, 2017)
- Classroom-based indicators of Success (*Principles to Actions,10th Anniversary*, 2024, p. 49)

Practice: Elicit and Use Evidence of Student Thinking

Overview

"Effective teaching of mathematics uses evidence of student thinking to assess progress toward mathematical understanding and to adjust instruction continually in ways that support and extend learning." (*Principles to Actions,10th Anniversary*, 2024, p. 53)

What are teachers doing?	What are students doing?
• Planning what student ideas and strategies should be selected and sequenced during the consolidation or debrief of a high-quality task • Recording where students are in their thinking to differentiate and provide questions that clarify, scaffold, and extend • Focusing on what students can do and what they know, as well as analyzing errors and misconceptions • Reflecting individually and collaboratively with colleagues on student work to determine next steps	• Representing their thinking orally, with different representations, or models • Using classmates' ideas to strengthen or challenge their own ideas • Supporting peers to ask questions, give feedback, and celebrate successes • Reflecting on mistakes and using them as opportunities to grow their understanding of concepts and procedures • Monitoring progress toward their mathematics learning goal and finding areas of improvement

Resources to Support Educator Understanding

- Effective Teaching Practices PtA Overview, (slides 31-32) (*Principles to Actions, 10th Anniversary*, 2024)
- Effective Teaching Practices Toolkit* (NCTM, 2014)
- Student Work Analysis Activity by Student Achievement Partners (Student Achievement Partners, n.d.)
- Using Aggressive Active Monitoring to Maximize Student Achievement (Model Teaching, 2019)
- Assignment Review Protocols (TNTP, n.d.)
- EQuIP Student Work Protocol (Achieve, 2016)

Tools to Support Implementation

- 5 Practices Monitoring Student Responses Planning Tool (Iowa Department of Education, n.d.)

Works Consulted

(Includes sources not directly cited but utilized in developing this document.)

Achieve. (n.d.). *EQuIP student work protocol.*

Achieve the Core. (n.d.). *Coherence map.*

Bay-Williams, J. M., & Kling, G. (2019). *Math fact fluency: 60+ games and assessment tools to support learning and retention.* Corwin.

Bay-Williams, J. M., & SanGiovanni, J. J. (2021). *Figuring out fluency in mathematics: A teacher's guide to balancing conceptual understanding and procedural skill.* Corwin.

Boaler, J. (2016). *Mathematical mindsets: Unleashing students' potential through creative math, inspiring messages, and innovative teaching.* Jossey-Bass.

Brookings Institution. (2012). *Choosing blindly: Instructional materials, teacher effectiveness, and the Common Core.* Brown Center.

Chapin, S., O'Connor, C., & Anderson, N. (2013). *Classroom discussions in math: A teacher's guide for using talk moves to support the Common Core and more* (2nd ed.). Math Solutions.