



Construct Viable Arguments and Critique the Reasoning of Others

Competency

Educators will engage and support students to construct viable arguments and critique the reasoning of others.

Key Method

Educators will analyze a student task, and the proficiency levels of the students, and explain Mathematical Practice Standard 3, *Construct Viable Arguments and Critique the Reasoning of Others*, to stakeholders.

Method Components

Mathematical Practices

The Standards for Mathematical Practice describe varieties of expertise that mathematics educators at all levels should seek to develop in their students. These practices rest on important “processes and proficiencies” with longstanding importance in mathematics education.

The first of these is the [NCTM process standards from the National Council of Teachers of Mathematics \(NCTM\)](#). The second is the strands of mathematical proficiency specified in the National Research Council's report [Adding It Up](#).

These process standards are:

- Problem-Solving
- Reasoning and Proof
- Communication



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- Connections
- Representation

Strive to build these dispositions in students:

- Adaptive reasoning
- Strategic competence
- Conceptual understanding
- Procedural fluency
- Productive struggle

These are the eight standards for mathematical practice:

1. Make sense of problems and persevere in solving them
2. Reason abstractly and quantitatively
3. Construct viable arguments and critique the reasoning of others
4. Model with mathematics
5. Use appropriate tools strategically
6. Attend to precision
7. Look for and make use of the structure
8. Look for and Express regularity in repeated reasoning

Talking about Mathematics: The importance of language in mathematics instruction and practice

Mathematics is a language and students need to become proficient in it. In the process, students need to understand and routinely apply the language of mathematics, which includes vocabulary, symbols, and sentence structures. The language of mathematics crosses all the standards for mathematical practice, so providing ample opportunities for students to learn and apply this language, both independently and collaboratively, will support their mathematical proficiency.

Explaining math can include the following:

- Words
- Pictures
- Mathematical expressions
- Using visual aids such as graphs
- Number lines
- Diagrams
- Drawing shapes with arm movement

Using the visuals above will help all students but especially those with multi-lingual skills.

Assessing Mathematics



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Assessing student learning is vital to progress in learning and steering instruction to ensure learning growth. It's important to ensure that assessments include these core components:

- Outcomes that are clear and measurable
- Opportunities for learners to show in a variety of ways, that they understand outcomes
- Assessment results that can be used to change instruction as needed to improve student learning

Constructing Viable Arguments and Critiquing the Reasoning of Others

In the realm of education, particularly in mathematics, constructing viable arguments and critiquing the reasoning of others plays a pivotal role in deepening understanding and fostering critical thinking skills. This approach involves encouraging students to articulate their thought processes and solutions to problems, and then inviting their peers to analyze and provide feedback on these methods.

Proficient students can:

- Understand and use stated assumptions, definitions, and previously established results in constructing arguments
- Make conjectures and build a logical progression of statements to explore the truth of their conjectures
- Analyze situations by breaking them into cases and recognize and use counterexamples
- Justify their conclusions, communicate them to others, and respond to the arguments of others
- Reason inductively about data, making plausible arguments that take into account the context from which the data arose
- Compare the effectiveness of two plausible arguments, distinguish correct logic or reasoning from that which is flawed, and—if there is a flaw in an argument—explain what it is.
- Construct arguments using concrete referents such as objects, drawings, diagrams, and actions (elementary)
- Determine domains to which an argument applies (middle and high school)
- Can listen to or read the arguments of others, decide whether they make sense, and ask useful questions to clarify or improve the arguments.

Assessing Mathematics

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- Assessment results that can be used to change instruction as needed to improve student learning

Strategies that Teach Students to Make and Critique Mathematical Arguments

Pedagogical strategies that support mathematical thinkers are important when planning math instruction. Strategies may include:

- Celebrating the use of models and different types of math reasoning
- Asking non-routine problems
- Encouraging students to use multiple representations of their mathematical thinking and reasoning
- Encouraging students to use visual representations and manipulatives in their reflection
- Asking learners to find multiple solutions
- Having learners share in various ways what they understand
- Using talk moves
- Actively listening
- Celebrating multiple ways students solve mathematical problems
- Using read-alouds to spark discussion
- Praising perseverance and growth
- Asking students "why?" to create a classroom culture where justification is expected.

Supporting Rationale and Research

Clayton, H. (2014). Thinking Behind the Content: Standards for Mathematical Practice. Just ASK Publications. Retrieved November 7, 2022, from <https://justaskpublications.com/just-ask-resource-center/e-newsletters/msca/thinking-behind-the-content-standards-for-mathematical-practice/>

Elementary Math at EDC. (2020). *MP: Why do we need standards for Mathematical Practice? – Elementary Math*. Elementary Math. Retrieved November 7, 2022, from <https://elementarymath.edc.org/resources/why-do-we-need-standards-for-mathematical-practice/>

Ernst-Slavit, G., & Slavit, D. (2021). *Mathematically Speaking*. Language Magazine.



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Retrieved November 7, 2022, from

<https://www.languagemagazine.com/mathematically-speaking/>

Illustrative Mathematics. (2016). *Illustrative Mathematics*. Retrieved November 7, 2022, from <http://tasks.illustrativemathematics.org/practice-standards/>

Jamison, R. E. (2000, May). Learning the Language of Mathematics. *Language and Learning Across the Disciplines*, 4(1), 45-54.

<https://wac.colostate.edu/docs/llad/v4n1/jamison.pdf>

Keazer, L., & Jung, H. (2020). Prospective teachers anticipate challenges fostering the mathematical practice of making sense. *School Science and Mathematics*, 120(2), 78-89. <https://onlinelibrary.wiley.com/doi/10.1111/ssm.12390>

Made4Math. (2020, May 12). *9 Easy Tips for Teaching Standards for Mathematical Practice*. Made4Math. Retrieved November 7, 2022, from

<https://www.made4math.com/standards-for-mathematical-practice/>

Rosenfeld, R. (2020, October 4). *Extending the Mathematical Practice Standards Across the Curriculum*. WestEd. Retrieved November 7, 2022, from

<https://www.wested.org/wested-bulletin/insights-impact/mathematical-practice-standards-across-the-curriculum/>

The University of Texas at Austin Charles A. Dana Center. (2022). *Mathematical Practice Standards*. Inside Mathematics. Retrieved November 7, 2022, from

<https://www.insidemathematics.org/common-core-resources/mathematical-practice-standards>

Resources

Curriculum and Standards

[Classroom Resources - National Council of Teachers of Mathematics](#)

[Achievethecore.org: Instructional Content Nav - Mathematics: Focus by Grade Level](#)

[Math Ed Reports](#)

[Mathematics Standards](#)

[MP3 Examples](#)

[MP3 Construct viable arguments and critique the reasoning of others – Elementary Math](#)



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[Process - National Council of Teachers of Mathematics](#)

[Standard 3: Construct Viable Arguments & Critique the Reasoning of Others |](#)

[Inside Mathematics](#)

[Standards for Mathematical Practice](#)

[The Standards for Mathematical Practice & Instructional Materials - Peers and Pedagogy](#)

[Deep Dive: How Math Practices 1-3 Help All Students Access Math Learning and Build Skills for the Future](#)

Assessment and Strategies for Mathematics

[6 Simple \(But Effective\) Instructional Strategies for Mathematics](#)

[9 Easy Tips for Teaching Standards for Mathematical Practice](#)

[Math Reasoning: Problem-Solving Strategies](#)

[Talk moves](#)

[Fostering Math Practices Decide and Defend](#)

Submission Guidelines & Evaluation Criteria

To earn the micro-credential, you must receive a passing score in Parts 1 and 3, and be proficient for all components in Part 2.

Part 1. Overview Questions (Provides Context)

(250-400 words):

Please use the suggested word count to answer *the following contextual questions. This will help our assessor understand your current context for working on this micro-credential.*

Please do not include any information that will make you identifiable to your reviewers.



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1. Why did you choose to work on this micro-credential? (Include your own career goals and your current teaching assignment.)
2. What is your experience with Math Practices?
3. Describe your student demographics.
4. As a result of working on this micro-credential, what would you like your students to be able to do?

Passing: Response provides reasonable and accurate information that justifies the reason for choosing this micro-credential to address the specific needs of both the teacher and the student. Clearly state a learning goal that describes what you hope to gain from earning this micro-credential and how your students may benefit.

Part 2. Work Examples/Artifacts/Evidence

To earn this micro-credential, please submit the following three artifacts as evidence of your learning.

**Please do not include any information that will make you or your students identifiable to your reviewers.*

Artifact 1: Task Analysis

Extract a problem or task from a lesson that allows students to engage in Math Practice 3. Utilize the implementation characteristics identified under Math Practice 3 on [Achieve the Core's Implementing Standards for Mathematical Practices](#) to analyze the problem or task.

Task analysis must include the following:

- The problem or task
- The mathematics standard(s) addressed and any learning objectives/outcomes
- How the task addresses the implementation characteristics

Artifact 2: Annotated Student work from task

Teach the task you analyzed in Artifact 1 and upload two student work samples that reflect different levels of proficiency of Math Practice 3. The samples must include

- Annotations that identify at least one strength for each student
- Annotations that identify at least one step toward proficiency for each student

OR



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Make a 2-minute video that shows you teaching and interacting with students, for the task you analyzed in Artifact 1

Your video must include the following:

- Verbal identification of one strength (either during the recorded conversation or in a voiceover)
 - For example: While working with your student(s), pause and say something like, "I am noticing that you are good at _____."
- Verbal identification of at least one step toward proficiency for each student (either during the recorded conversation or in a voiceover)
 - For example: At the end of the lesson, say to your student(s) "I am so proud of the way you----. A good next step for you to work on is----."

Follow your district's mandated permissions for photography with students.

Video tips: Video students from the back of the head or from the neck down; avoid or block their faces. Narrate or display information to explain the learning intended for the Math Practice.

**You will need to upload your video to YouTube or another video hosting platform. Please make sure your sharing permissions are set to anyone with the link can view it. You can change this after you have earned this micro-credential.*

Artifact 3: One-Page Handout

Use [Achieve the Core's Implementing Standards for Mathematical Practices](#) to create a one-page handout for families and/or support professionals that synthesizes how they can support students at home or at school, to construct viable arguments and critique the reasoning of others. Your one-page handout needs to include the following:

- Your intended audience: families, support professionals, or both
- Explanation of Math Practice 3
- What students should be able to do (in language that students understand)
- Questions (2-3) and/or prompts to guide students through the process
- What to do when a student is stuck
- 1-3 Resources/links to use at home, in a resource room, or in another location

Part 2. Rubric

	Proficient	Basic	Developing
Artifact 1: Task Analysis	The task analysis includes all the following: <ul style="list-style-type: none"> ● The problem and task 	The task analysis includes some of the following: <ul style="list-style-type: none"> ● The problem and task 	The task analysis does not sufficiently include any of the following:



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	<ul style="list-style-type: none"> • The math standard(s) and objectives and outcomes • The Four Implementation Characteristics of Mathematical Practice 3 • How the task addresses the implementation characteristics 	<ul style="list-style-type: none"> • The math standard(s) and objectives and outcomes • The Four Implementation Characteristics of Mathematical Practice 3 • How the task addresses the implementation characteristics 	<ul style="list-style-type: none"> • the problem and task • the math standard(s) and objectives and outcomes • The Four Implementation Characteristics of Mathematical Practice 3 • How the task addresses the implementation characteristics
<p>Artifact 2: Student evidence from task</p> <p>Samples of student work Option</p>	<p>Student samples include all the following:</p> <ul style="list-style-type: none"> • Two samples displaying different levels of Math Practice 3 • Written annotations that identify at least one strength for each student • Written annotations that identify at least one step toward proficiency for each student 	<p>Student samples include some of the following:</p> <ul style="list-style-type: none"> • Two samples displaying different levels of Math Practice 3 • Written annotations that identify at least one strength for each student • Written annotations that identify at least one step toward proficiency for each student 	<p>Student samples do not sufficiently include any of the following:</p> <ul style="list-style-type: none"> • Two samples displaying different levels of Math Practice 3 • Written annotations that identify at least one strength for each student • Written annotations that identify at least one step toward proficiency for each student
<p>Artifact 2: Student evidence from task</p> <p>Video Option</p>	<p>Videos include all the following:</p> <ul style="list-style-type: none"> • At least one strength (either during the recorded conversation) 	<p>Videos include some of the following:</p> <ul style="list-style-type: none"> • At least one strength (either during the recorded conversation) 	<p>Videos do not sufficiently include any of the following:</p> <ul style="list-style-type: none"> • At least one strength (either during the recorded conversation)



	<p>or in a voiceover)</p> <ul style="list-style-type: none"> At least one step toward proficiency for each student (during the recorded conversation or in a voiceover) 	<p>or in a voiceover)</p> <ul style="list-style-type: none"> At least one step toward proficiency for each student (during the recorded conversation or in a voiceover) 	<p>conversation or in a voiceover)</p> <ul style="list-style-type: none"> At least one step toward proficiency for each student (during the recorded conversation or in a voiceover)
<p>Artifact 3: One Page Handout</p>	<p>The one-page handout clearly shows how to help students construct viable arguments and critique the reasoning of others.</p> <p>And includes the following:</p> <ul style="list-style-type: none"> Your intended audience: families, support professionals, or both Explanation of Math Practice 3 What students should be able to do (in student language) Questions (2-3) and/or prompts to guide students through the process What to do when a 	<p>The one-page handout attempts to show how to help students construct viable arguments and critique the reasoning of others</p> <p>It includes all but two of the following:</p> <ul style="list-style-type: none"> Your intended audience: families, support professionals, or both Explanation of Math Practice 3 What students should be able to do (in student language) Questions (2-3) and/or prompts to guide students through the process What to do when a 	<p>The one-page handout does not show how to help students construct viable arguments and critique the reasoning of others</p> <p>It is missing three or more of the following:</p> <ul style="list-style-type: none"> Your intended audience: families, support professionals, or both Explanation of Math Practice 3 What students should be able to do (in student language) Questions (2-3) and/or prompts to guide students through the process What to do when a student is stuck



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	<p>student is stuck</p> <ul style="list-style-type: none"> Resources/links (1-3) to use at home, in a resource room, or in another location 	<p>student is stuck</p> <ul style="list-style-type: none"> Resources/links (1-3) to use at home, in a resource room, or in another location 	<ul style="list-style-type: none"> Resources/links (1-3) to use at home, in a resource room, or in another location
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Part 3 Reflection

(400-600 words)

Use the word count as a guide to write a personal reflection about your work on this micro-credential. For tips on writing a good reflection, review this resource:

[How Do I Write a Good Personal Reflection?](#)

Please do not include any information that will make you identifiable to your reviewers.

1. How did thinking about Math Practice 3 impact how you approached this task? Describe any shifts in understanding you or your students had.
2. Reflect on your role in facilitating student learning about Math Practice 3 on this task. In your response, include details from student work and your feedback in Artifact 2.
3. What next steps can you take moving forward? How will you make this process part of your regular practice?

Passing: Reflection proves that this activity has positively impacted educator practice and student success. Specific examples are cited from personal or work-related experiences to support claims. Also included are specific, actionable steps to demonstrate how new learning will be integrated into future practices.



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