

Assessment Strategies in Mathematics Classrooms

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Research Recommendations for Assessment

- ▶ “An assessment system designed to help steer the instruction system must give good information about direction as well as distance to travel. A system that keeps telling us we are not there yet is like a kid in the back seat whining ‘are we there yet’” (Daro, Mosher, & Corcoran, 2011, p.51)
- ▶ Assessment should enhance student’s learning, provide helpful feedback to the student and the teacher (AMTE)
- ▶ Assessment should be aligned to standards and include mathematical practices such as justifying, modeling, attention to precision (Fennell, Kobett, & Wray, 2017)
- ▶ Should include a cycle of formative assessment and feedback (several times), then summative assessment (William & Leahy, 2015)
- ▶ Formative assessment increases speed and amount of student learning (William & Leahy, 2015)

No Scoring Guide

- ▶ Assess the student work example on a scale of 0-10. What led you to choose the score you did?
- ▶ What elements were present that you gave credit?
- ▶ What elements were missing that you would like to see in an exemplary response?

Student Work Sample 1

Student work samples distributed in session.

Holistic Scoring Guides (Rubrics)

- ▶ Samples are given a single overall score
- ▶ Give teachers an overall assessment of the topic rather than specific strengths and weaknesses
- ▶ More suitable for summative than formative assessment
- ▶ Can make scoring large numbers of projects easier
- ▶ Better when all samples are scored by the same teacher

Holistic Scoring Guide Sample

Score	Criteria
10	Exemplary Answer is correct Thinking is appropriate, sophisticated, and clearly communicated Attention to precision is present
8	Proficient Answer is correct Minor omissions or incorrect use of symbols, units, etc... that do not indicate misunderstanding of the major content
6	Approaching Expectations Answer is reasonable Some understanding is shown, but there is an error that indicate possible misconceptions
4	Progressing Some attempt was made, and some parts are connected to the problem Multiple significant errors exist that indicate possible misconceptions
2	Some attempt was made, but the attempt seems disconnected from the problem
0	No attempt was made

Analytic Scoring Guides (Rubrics)

- ▶ Different criteria are considered when scoring the response
- ▶ Responses may score high in one area and low in another
- ▶ Different criteria may hold different weights
 - ▶ Weights tell students what we value
- ▶ Cells of the rubric should clearly indicate the level of performance that falls within that designation
- ▶ Suitable for formative assessment because they give the student and teacher detailed feedback
- ▶ Are less ambiguous and subjective than holistic scoring guides

Analytic Scoring Guide Sample

	4 points	3 points	2 points	1 point	0 points
Solution			Solution is completely correct and clear. It is appropriately labeled.	Solution is correct, or a close approximation, but has minor errors in labeling or is not clear.	Solution is incorrect, or it is unclear where the solution appears.
Strategy	Strategy is completely appropriate for the problem, is well-conceived, and has no obvious errors.	Strategy is appropriate for the problem, but has a minor error that does not suggest a misconception, but rather a calculation error.	Strategy is mostly appropriate for problem, but has a significant error that suggests a misconception may exist. Alternatively, multiple minor errors, as noted under 3 points, exist.	Strategy is not appropriate for problem and suggests a major misconception exists, but some meaningful attempt was made. Alternatively, multiple significant errors exist, or strategy is unclear.	No attempt to solve the problem was made, or strategy appears not to be related to the problem being solved.
Notation			There are no errors in notation involving concepts discussed in class. Ex: Equals sign usage, accurate mathematical vocabulary, units expressed carefully.	One or two errors appear, such as those listed under 2 points.	Three or more errors appear, or one major error that suggests significant misconception.
Explanation			Elaborate, uses appropriate vocabulary, could be followed by a student at the same level, no gaps.	Minor gap or unclear claim, but still makes sense and accurately shows process, OR all thinking is shown, but is unorganized and hard to follow.	Not thorough or lacking appropriate detail

Student Work Sample 2

Student work samples distributed in session.

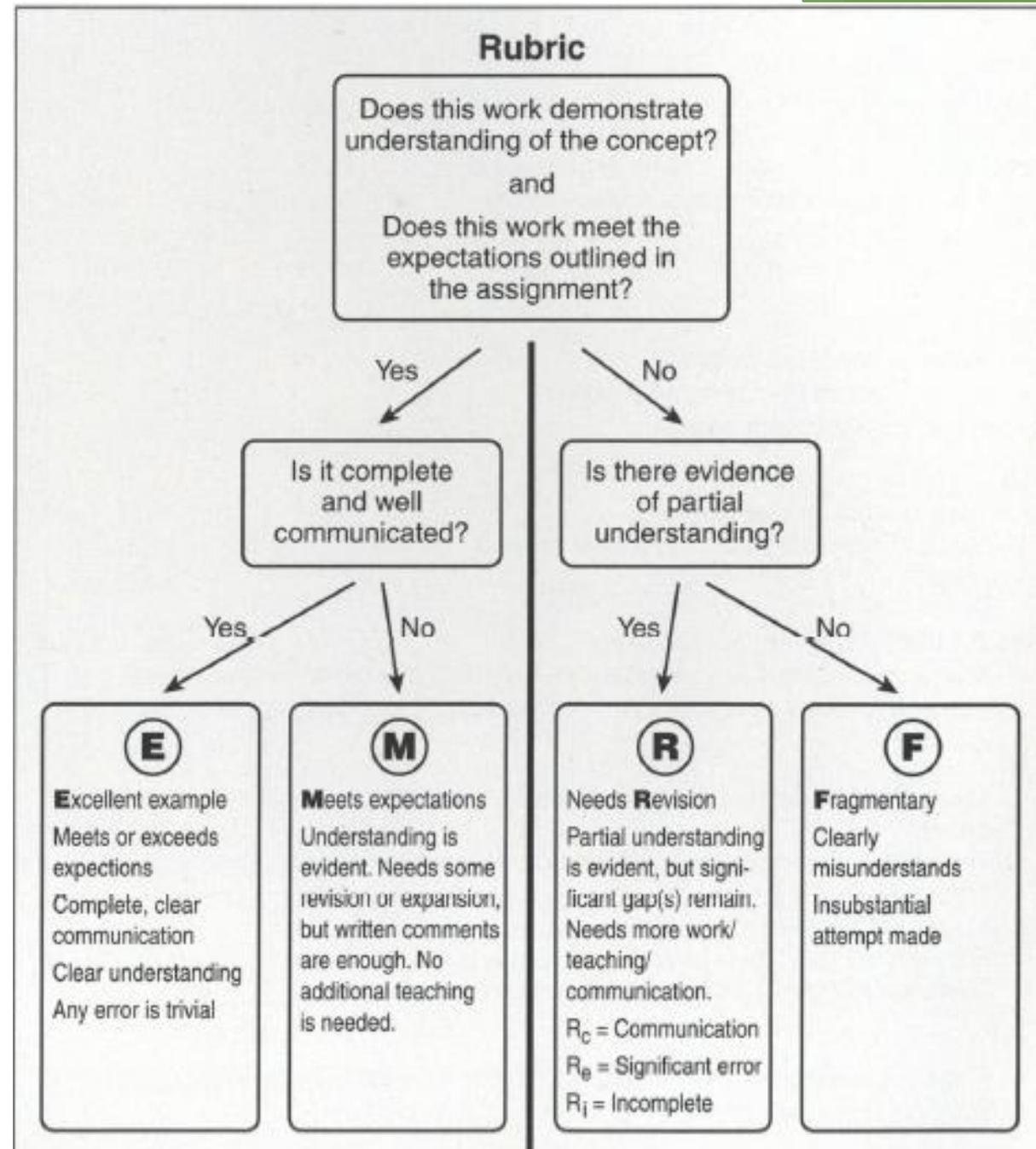
Student Work Sample 3

Student work samples distributed in session.

Student Work Sample 4

Student work samples distributed in session.

Other Rubrics I Like



(Stutzman & Race, 2016)

Other Rubrics I Like

$A + E + I + O = U$ High-Five It!

A for ANSWER

- 5 Answer is accurate; it responds directly to the question asked, is clearly noted, and is labeled appropriately. Answer statement indicates that the student understands the question.
- 4 Answer is reasonable and very close to accurate but is off by a slight amount or mislabeled in a minor way (e.g., student uses cm. rather than in.). Or answer is an estimate but labeled as exact when an exact answer is required (e.g., student supplies 1.41 when radical 2 is required).
- 3 Answer is reasonable or accurate but is seriously mislabeled (e.g., student labels an area as cm. rather than as square cm.)
- 2 Answer is provided and arrived at by a reasonable process but is not reasonable or off by a large factor (e.g., student gives a building's height as 40,000 feet rather than 400 feet).
- 1 Answer is not reasonable or is essentially missing.

Answer + Explanation + Information + Organization =
Understanding

(Vazquez, 2008)

$A + E + I + O = U$ High-Five It!

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E for EFFICIENT EXPLANATION

- 5 Explanation is clear, efficient, and flawless, or student provides multiple explanations and connects these to one other, as in checking one process with a second approach.
- 4 Explanation is effective but not necessarily the most efficient choice. Or the description may be correct but awkward or verbose, expressed without the use of mathematical notation or symbols.
- 3 Explanation is adequate and effective but may contain one or two minor gaps where conclusions or steps along the way to the answer are reached or stated without explanation.
- 2 Explanation is started; the process begun could be effective if completed.
- 1 Explanation does not demonstrate an appropriate strategy or is essentially missing.

I for INFORMATION

- 5 Information needed to solve the problem is complete and clearly noted. All quantities are labeled, and their origin in the process is clearly visible. Mathematical notations are correctly used, and terms are defined.
- 4 Information is mostly available and labeled appropriately, but minor errors exist or labels are missing (e.g., a major piece of the problem solution such as "2 cm. per every 3 minutes" is simply stated as "2/3").
- 3 Most quantities are labeled, but some missing labels confuse the process.
- 2 Quantities are incorrectly labeled or are missing labels. Variables are used without being defined.
- 1 Labels and notation are few or lacking.

O for ORGANIZATION

- 5 Organization is thorough and complete. The student's thought process can be followed in the explanation, and steps are clearly labeled or in logical order.
- 4 Process flows in order, but some minor steps that the student may consider obvious have been skipped.
- 3 Steps follow in order or are marked; however, the process may contain run-on equations or missed steps that confuse the explanation (e.g., in arriving at an answer of 30 inches from 3 feet minus 6 inches, a student may write "12 · 3 - 36 - 6 = 30 inches," showing little regard for the equal sign or unit consistency).
- 2 Some attempt has been made to organize the process, but steps are out of order or steps critical to the process are missing.
- 1 Process is messy, illegible, or obscured and is difficult or impossible to follow

Which equals

U for UNDERSTANDING

Exemplars[®] Classic 3-Level Math Rubric

Other Rubrics Like

Level	Understanding	Strategies, Reasoning, Procedures	Communication
Novice	<ul style="list-style-type: none"> There is no solution, or the solution has no relationship to the task. Inappropriate concepts are applied and/or procedures are used. The solution addresses none of the mathematical components presented in the task. 	<ul style="list-style-type: none"> No evidence of a strategy or procedure, or uses a strategy that does not help solve the problem. No evidence of mathematical reasoning. There were so many errors in mathematical procedures that the problem could not be solved. 	<ul style="list-style-type: none"> There is no explanation of the solution, the explanation cannot be understood or it is unrelated to the problem. There is no use or inappropriate use of mathematical representations (e.g. figures diagrams, graphs, tables, etc.). There is no use, or mostly inappropriate use, of mathematical terminology and notation.
Apprentice	<ul style="list-style-type: none"> The solution is not complete indicating that parts of the problem are not understood. The solution addresses some, but not all of the mathematical components presented in the task. 	<ul style="list-style-type: none"> Uses a strategy that is partially useful, leading some way toward a solution, but not to a full solution of the problem. Some evidence of mathematical reasoning. Could not completely carry out mathematical procedures. Some parts may be correct, but a correct answer is not achieved. 	<ul style="list-style-type: none"> There is an incomplete explanation; it may not be clearly presented. There is some use of appropriate mathematical representation. There is some use of mathematical terminology and notation appropriate of the problem.
Practitioner	<ul style="list-style-type: none"> The solution shows that the Student has a broad understanding of the problem and the major concepts necessary for its solution. The solution addresses <u>all</u> of the mathematical components presented in the task. 	<ul style="list-style-type: none"> Uses a strategy that leads to a solution of the problem. Uses effective mathematical reasoning. Mathematical procedures used. All parts are correct and a correct answer is achieved. 	<ul style="list-style-type: none"> There is a clear explanation. There is appropriate use of accurate mathematical representation. There is effective use of mathematical terminology and notation.
Expert	<ul style="list-style-type: none"> The solution shows a deep understanding of the problem including the ability to identify the appropriate mathematical concepts and the information necessary for its solution. The solution completely addresses all mathematical components presented in the task. The solution puts to use the underlying mathematical concepts upon which the task is designed. 	<ul style="list-style-type: none"> Uses a very efficient and sophisticated strategy leading directly to a solution. Employs refined and complex reasoning. Applies procedures accurately to correctly solve the problem and verify the results. Verifies solution and/or evaluates the reasonableness of the solution. Makes mathematically relevant observations and/or connections. 	<ul style="list-style-type: none"> There is a clear, effective explanation detailing how the problem is solved. All of the steps are included so that the reader does not need to infer how and why decisions were made. Mathematical representation is actively used as a means of communicating ideas related to the solution of the problem. There is precise and appropriate use of mathematical terminology and notation

Other Rubrics I Like

	Level 1 I Need to Make This a Goal!	Level 2 I'm Moving in the Right Direction!	Level 3 I'm Right on Track!	Level 4 Wow! My Work is Impressive!
	This is hard, I need some help to understand more.	I know some things about but I still have lots of questions.	I feel like I know a lot about .	is easy to understand and I like to challenge myself.

	Level 1 Let's Make This a Goal!	Level 2 Moving in the Right Direction!	Level 3 Right on Track!	Level 4 Wow! That's impressive!
Knowledge and Understanding	Understanding Traditions Around the World was challenging for you, but don't worry we will review this topic again. Look over your work and remember to put in a big effort.	You understand some things about Traditions Around the World . You're moving in the right direction but you still need a little help from your teacher and a bit more practice.	You show considerable understanding of Traditions Around the World . For the most part, you're working independently.	You have a thorough understanding of Traditions Around the World . The concepts come to you easily and you put in the effort to go above and beyond what is expected.
	Example Comment: <i>Remember to provide more examples on your comparison chart.</i>			

(Ontario Teachers Federation, 2018)

Alternative Assessment Methods for Younger Students (or older)

(Van de Walle, Karp, & Bay-Williams, 2016)

Topic:	Not There Yet	On Target	Above and Beyond	Comments
Mental Computation Adding 2-digit numbers	<i>Can't do mentally</i>	<i>Has at least one strategy</i>	<i>Uses different methods with different numbers</i>	
Names				
Lalie		✓ 3-18-09 3-21-09		
Pete	✓ 3-20-09	✓ 3-24-09		<i>Difficulty with problems requiring regrouping</i>
Sid			✓+ 3-20-09	<i>Flexible approaches used</i>
Lakeshia		✓		<i>Counts by tens, then adds ones</i>
George		✓		
Pam	✓			<i>Beginning to add the group of tens first</i>
Maria		✓ 3-24-09		<i>Using a posted hundreds chart</i>

Alternative Assessment Methods for Younger Students (or older)

Observation Rubric Making Whole Given Fraction Part 3/17	
<p>Above and Beyond Clear understanding. Communicates concept in multiple representations. Shows evidence of using idea without prompting.</p> <p><i>Fraction whole made from parts in rods and in sets. Explains easily.</i></p>	<p>Sally</p> <p>Latania</p> <p>Greg Zal</p>
<p>On Target Understands or is developing well. Uses designated models.</p> <p><i>Can make whole in either rod or set format (note). Hesitant. Needs prompt to identify unit fraction.</i></p>	<p>Lavant (rod) Tanisha (rod)</p> <p>Julie (rod) Lee (set)</p> <p>George (set) J.B. (rod)</p> <p>Maria (set) John H. (rod)</p>
<p>Not There Yet Some confusion or misunderstands. Only models idea with help.</p> <p><i>Needs help to do activity. No confidence.</i></p>	<p>John S. Mary</p>

(Van de Walle, Karp, & Bay-Williams, 2016)

Using with Standards-Based Grading

- ▶ Grades reflect student mastery of set standards
- ▶ Use is quickly increasing in elementary, middle and high schools
- ▶ Mastery can increase throughout the semester
- ▶ Encourages growth mindset in students (future teachers)
- ▶ Encourages students to find and understand their areas of need and work to fill that gap
- ▶ Students have responded very positively
- ▶ Increased visits during office hours, more focused questions

Ongoing Research

- ▶ Currently using 10-point analytic rubric in 3 sections of MATH 1420
 - ▶ 99% Standards-based grading
- ▶ Plan to analyze student mastery and student satisfaction with the course

References

- ▶ Daro, P., Mosher, F., & Corcoran, T. (2011). *Learning trajectories in mathematics: A foundation for standards, curriculum assessment, and instruction*. Philadelphia, PA: Consortium for Policy research in Education.
- ▶ Fennell, F., Kobett, B.M., & Wray, J. (2017). *Formative five: Everyday assessment techniques for every classroom*. Thousand Oaks, CA: Corwin.
- ▶ Ontario Teachers' Federation. (2018). Instructional, Positive, Kid-Friendly Rubrics. <https://www.otffeo.on.ca/en/resources/lesson-plans/instructional-positive-kid-friendly-rubrics/>
- ▶ Stutzman, R., & Race, K. (2016). Everyday grading rubric. *Mathematics Teacher*, 97(1), 34-39.
- ▶ Van de Walle, J., Karp, K., & Bay-Williams, J. (2016). *Elementary and Middle School Mathematics: Teaching Developmentally*.
- ▶ Vazquez, L. (2008). A, E, I, O, U, and always Y. *Mathematics Teacher*, 102(1), 16-23.
- ▶ Wiliam, D. & Leahy, S. (2015). *Embedding formative assessment: Practical techniques for K-12 classrooms*. West Palm beach, FL: Learning Sciences International.

Thank you!

Questions?

Feedback?

Suggestions?

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