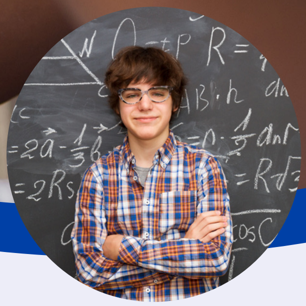
RIVERSIDE COUNTY OFFICE OF EDUCATION
EDWIN GOMEZ, Ed.D.
County Superintendent of Schools

Division of Educational Services
Instructional Services



A Proposed Vision for MATHEMATICS EDUCATION – FORMATIVE ASSESSMENT

WHITEPAPER | MARCH 2020

Developed by Mathematics Task Force 2017–2019
RIVERSIDE COUNTY OFFICE OF EDUCATION

ACKNOWLEDGEMENTS

We would like to thank all teachers and administrators from Riverside County who gave of their time to share insight into the challenges and struggles that our students and districts face with respect to increasing mathematics achievement and producing a well-prepared citizenry.

Special thanks to the following individuals and districts for the initial and ongoing support of this work:

Karon Akins
Administrator, Instructional Services
Riverside County Office of Education
kakins@rcoe.us

Mike Barney
Executive Director, Instructional Services
Educational Services
Riverside County Office of Education
mbarney@rcoe.us

Diana Ceja
Administrator, Instructional Services
Riverside County Office of Education
dceja@rcoe.us

Donald Havenhill
Instructional Coach
Corona-Norco Unified School District
dhavenhill@cnusd.k12.ca.us

Susan Estrada Jaggers
District Administrator
Riverside Unified School District
sjaggers@riversideunified.org

Annette Kitigawa
Retired Administrator, Instructional Services
Riverside County Office of Education

Vicky Kukuruda
Retired Administrator, Instructional Services
Riverside County Office of Education

David Mattoon
Instructional Coach
Hemet Unified School District
dmattoon@hemetusd.org

Krista Moomey
Classroom Teacher
Nuview Union School District
kmoomey@nuview.k12.ca.us

Dennis Regus
Administrator, Instructional Services
Riverside County Office of Education
dregus@rcoe.us

Shirley Roath
Administrator, Instructional Services
Riverside County Office of Education
sroath@rcoe.us

Jennifer Ruder
Classroom Math Teacher
Menifee Union School District

Erica Williams
Classroom Math Teacher
Site Administrator
Nuview Union School District
ewilliams@nuview.k12.ca.us

Jen Tanis
Instructional Coach
Riverside Unified School District
jtanis@riversideunified.org

Laura Ferreira
District Administrator
Riverside Unified School District
lferreira@riversideunified.org

M. Christine Ventrella
Instructional Coach
Corona-Norco Unified School District
mventrella@cnusd.k12.ca.us

Colleen Westfall
Instructional Coach
Riverside Unified School District

A Proposed Vision for MATHEMATICS EDUCATION – FORMATIVE ASSESSMENT

Background

Mathematics is deeply embedded in many aspects of our daily life, both seen and unseen, such as modern communications, transportation systems, medicine, and “big data” sets (Catalyzing Change, 2018). Additionally, it serves as the foundation for careers in science, technology, engineering, and mathematics (STEM) and increasingly as the underpinnings for careers outside of STEM. Mathematics is at the core of most innovations in the “information economy” which is increasingly driven by data. The digital age continues to inundate us with data, rates, quantities, probabilities and averages. This 21st century trend intensifies the importance and need for students to be mathematically, and statistically literate consumers and producers of information (Catalyzing Change, 2018).

In 2010 a shift began to occur in the way we think about and teach TK-12 mathematics. This change has been a monumental undertaking for the TK-12 educational community. It was brought about by the adoption of new California State Standards for mathematics by the CA State Board of Education. The adoption of mathematical practice and content standards that align to the rigor of both international standards and expectations set forth by the National Council of Mathematics (NCTM), require shifting our focus to the habits of mind that mathematicians must develop over time. This is a call to action for math teachers, school and district administrators, community members, and students to engage in an expanded and more meaningful mathematics in order to meet the expectations of the 21st century. The jobs for which our students will compete no longer require them to be fluent in skills such as adding fractions with unlike denominators, factoring quadratic equations, or synthetic division to name a few. In fact, since the 1990s there have been technological tools that can perform these processes for us. One should ask, what have we in education been waiting for? Why didn’t this shift start sooner? Every year that goes by without an intense focus on changing the policies that influence the teaching and learning of mathematics in our schools is time lost, resulting in thousands of children graduating unprepared to meet the quantitative demands of the world.

Math Task Force and Its Charge

The Math Task Force for Riverside County Office of Education was formed and charged with determining reasons for inequities and low achievement in mathematics, identifying the mathematical needs in our districts, and using research to recommend pathways for improvement.

LETTER TO INITIAL PARTICIPANTS

"You are invited to join the Mathematics Task Force because you and your team have been one to seek ideas by networking with other districts and using research-based tools/policies beyond the textbook and traditional instructional practices.

Mathematics is a gatekeeper for many of our students. If this practice continues, many of the future jobs will not be accessible to our students. Based on our county data, many of our students are not college and career ready in mathematics.

The goal of the task force is to identify the mathematics needs in our districts and use research to identify possible recommendations."

The Math Task Force researched key areas of focus to identify leverage points for sustainable systemic change. The group met over a two-year period with representatives from the following districts: Hemet USD, Menifee Union SD, Corona-Norco USD, Nuview Union SD, and Riverside USD. The districts were asked to send a district administrator, site administrator, district data administrator, and a teacher. Attendance by participating districts varied throughout the process.

Our Current Reality – Why So Little Has Changed...

Before we can capitalize on the opportunities provided through new standards, assessments, and accountability systems and address the challenges of the 21st century, we need to better understand why so little has changed. The National Council of Supervisors of Mathematics (NCSM) identified four factors to explain this lack of change and to frame the essential changes that need to be made.

1. "There is a widespread lack of mathematics content knowledge and pedagogical content knowledge required for teachers to maximize student learning..." Preliminary training is too often minimal and inadequate for new teachers to be successful and opportunities for continued learning are very limited.

2. "There are few mechanisms in place and insufficient time to improve mathematics content knowledge and pedagogical content knowledge." Teachers are inconsistently supervised, "under supported, and professionally isolated as they endure systems of evaluation that too often are not aligned with research-affirmed instructional practices."

3. "Too many schools fail to maximize the learning of their students. Again, this is not a statement of blame, but the facts are that few teachers have the benefit of a research-based vision of effective teaching practice. Far too many schools fail to make effective use of data to improve teaching and learning… The gap between what we know and what we do remains unacceptably wide. Improvement and real change requires a much more effective system of supporting the teaching and learning process."

4. "In mathematics education, to a much greater degree than English language arts, our efforts are often stymied by a culture of beliefs and mindsets that lower expectations and limit the opportunity to learn... Too often, our perceptions, policies, and practices fail to provide opportunities for all students, and in far too many places the link between high-quality mathematics education and social justice is missing from our actions as students fall through the cracks and leave school unprepared for the expectations and needs of today's workplace…" (NCSM, 2014)

KEY AREAS OF FOCUS

In an effort to respond to our current reality and provide pathways to change, the Math Task Force identified several key areas to transform math education in our TK-12 schools. While the Math Task Force is recommending a focus on Embedded Formative Assessment, all six areas are worthy of discussion at the district level. At the most foundational level, school sites, districts, and the county must have a shared vision of what mathematics is and how instruction and learning should look. The following key areas provide opportunities for districts to develop a shared vision around what will generate mathematics success for all students entrusted to us: (1) Assessment, (2) Teaching and Instruction, (3) Mindsets and Beliefs, (4) Agency, Ownership, and Identity, (5) Professionalism, and (6) Equitable Access.

Area of Focus 1: Assessment

Assessment encompasses a large variety of tools and strategies within mathematics. Typically, the word assessment is associated with formal tools such as statewide assessments, end of unit assessments, quizzes, etc. Within the TK-12 system, these are the assessments that are most often utilized to measure student learning. Considering the systemic beliefs associated with assessments, a need exists to foster a broader definition of assessment to include minute-by-minute and day-to-day embedded formative assessment.

Area of Focus 2: Teaching and Instruction

The task force discussed several integral components of instruction including the following:

- Teacher clarity is essential to student achievement. According to John Hattie's meta-analysis it has an effect size of 0.75. (Visible Learning for Mathematics, p. 40)
- Lesson development, delivery, and cognitive demand: According to the recent report *The Opportunity Myth* (2018), the average high school teacher teaches "on grade level" lessons 17% of the time and ELs and Students with Disabilities receive grade level instruction 10-13% of the time.
- Teachers and administrators need a better understanding of what it means to have a balance between procedural fluency and conceptual understanding. "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." (NCTM, 2014)

Area of Focus 3: Mindsets and Beliefs

Mindsets and beliefs play a vital and often undervalued role in education. As a society, we regularly admit when we are "not math people" or that we were not good at math. We have to recognize what being "good" at math means. We have to shift our understanding. Our goal should be that all students leave school as citizens that understand the value and integral role that mathematics plays in their lives. Not everyone will or should be a professor of mathematics, but our system shouldn't close this door for any student who wants to walk through it. The following beliefs and mindsets were discussed by the Math Task Force as needing to be addressed in order for real change to occur.

- We most often operate from deficit views of student ability. This means we spend most of our time determining what students lack rather than what students already know.
- A belief that computational fluency is required prior to application and conceptual understanding.
- A belief that computation rather than application is the only path to understanding and fluency.
- We have inconsistent expectations for students depending on student populations (or subgroups).
- Not all stakeholders believe there is a need to change.

Area of Focus 4: Agency, Ownership, and Identity

When we discuss agency in mathematics we refer to a student's willingness to engage in the learning. At a deeper level it is the extent to which students are provided opportunities to "walk the walk and talk the talk", to contribute to conversations about disciplinary ideas, to build on others' ideas and have others build on theirs in ways that contribute to their development of agency (the willingness to engage), their ownership over the content, and the development of positive identities as thinkers and learners (TRU Framework). We have to consider on a daily basis who is making sense of the mathematics in our classrooms. Is it the teacher or the students?

Area of Focus 5: Professionalism

There are several key components that were discussed regarding professionalism. A few of these include the need for higher expectations in teacher credentialing programs, a greater understanding of content, continual professional development, and the ability to know what is and is not working for students in your classroom. It is the opinion of the Math Task Force that it would be worthwhile to continue this discussion through the lens of the Model Code of Ethics (NASDTEC, MCEE; 2015).

Area of Focus 6: Equitable Access

This is defined as the extent to which classroom activity structures invite and support the active engagement of all the students in the classroom with the core disciplinary content being addressed by the class. Classrooms in which a small number of students get most of the "air time" are not equitable, no matter how rich the content: all students need to be involved in meaningful ways. (TRU Framework)

As stated above, these areas of focus are the recommendation of the Math Task Force. Districts can use these areas of focus as a starting point for mathematics educational reform. It is essential that districts develop a common vision around what each of these areas means to their district. These are complex, multi-faceted ideas that require our attention if we hope to improve mathematical outcomes for our students.

RECOMMENDATIONS FOR COUNTYWIDE FOCUS

Information the Math Task Force strongly recommends that the primary focus for RCOE should be on embedded formative assessment. A focus on embedded formative assessment can be used as a pathway to 1) increase student understanding of mathematics, 2) design on-demand teacher professional development, 3) focus on feedback and intervention, and 4) provide more equitable access for every student every day. It is the recommendation of the Math Task Force that RCOE should assist districts in the training of teachers and site/district leaders on the implementation of high quality embedded formative assessment practices.

There are several key questions that organizations must attend to in order to increase the focus on embedded formative assessment practices. These include but are not limited to:

1. What is your site or district's shared understanding of formative assessment?
2. What types of formative assessments do you use?
3. What role do students play in the formative assessment process?
4. How often are teachers collaborating around the data from formative assessments including student work samples?
5. How often are teachers using common assessments and/or student work samples (for collaboration) to inform instruction?
6. How frequently are students given actionable feedback on their learning? (Giving grades is not actionable feedback on learning).

Formative assessment should impact student learning. Student success indicators and how we measure these indicators are influenced by the formative assessment.

Defining Formative Assessment

As a common definition, formative assessment is the daily assessment practice of educators that inform next steps instructionally and provide intentional and actionable feedback to students. If students are not an integral part of the feedback and learning, then it is not formative assessment. Feedback has an effect size of 0.75 (Hattie, 2017). This type of assessment has the purpose of meeting students where they are and moving them forward.

"Formative assessments provide teachers and students with information about students' current thinking and misconceptions to enable better day-to-day instructional decision making and more meaningful student participation, thus providing teachers a process to monitor and provide feedback to students as well as to adjust teaching strategies." (Dylan Wiliam, 2011)

Descriptors of Formative Assessment

- The Formative Assessment Process is a reflective cycle of continuous learning that results in changed instruction and increased student outcomes.
- Information about student learning can be in the form of assessments, observations, student work samples, or discussions. It may be formal or informal.
- Feedback should be from the teacher to the student in an actionable format, allowing teachers to adjust their instruction so students can rethink misconceptions. "Feedback functions formatively only if the information fed back to the learner is used by the learner in improving performance."
  — *Dylan Wiliam, Embedded Formative Assessment*
- Instructional decision making adapts teaching and learning to meet immediate learning needs minute-to-minute and day-to-day.
- Meaningful student participation allows "students to reveal their emerging understandings, and provide opportunities both to rethink misunderstandings and to build on productive ideas." (TRU Mathematics, 2016)

"The undoubted power of formative assessment and the strength of the research base have led to a plethora of products and services that describe themselves as "formative assessment," but in reality very few embody the principles the research has shown are essential to enhance students' learning." (Shepard 2007).

The five strands of mathematical proficiency describe the habits of mind necessary to be mathematically literate. Productive and unproductive practices that influence the teaching and learning of mathematics, and how to measure these key strands through the lens of formative assessment are included. This section is intended to function as a guide for administrators and teachers when thinking about these pillars through the lens of formative assessment. Please note that measuring student progress within the realm of formative assessment almost always involves looking at student work samples. This section is by no means an exhaustive list.

STRAND 1: CONCEPTUAL UNDERSTANDING

Comprehension of mathematical concepts, operations, and relations (Adding It Up, 2001, p. 116).

Productive Practices:

Teachers should be intentional about ensuring students know more than isolated facts and methods and that they understand relationships between concepts and number. The focus of student thinking should be on choosing an approach that is efficient and appropriate for the context of the problem. Student work should show a variety of strategies as they make sense of ideas.

Guiding Questions:

1. Who is making sense of the mathematics during lessons?
2. Do students have a voice during lessons? Are they passive or active learners?
3. Is student work at the center of teacher conversations about teaching and learning?

Unproductive Practices:

The frequent or regular use of measures such as quizzes or exit tickets for summative purposes only. Measuring progress through the use of multiple-choice assessments that do not allow students to demonstrate their conceptual understanding or show their understanding using a variety of representations. A focus on correct answers versus the thinking that helped derive the correct answer.

Measures:

Student work samples should be used to measure the development of conceptual understanding in our students. A significant indicator of conceptual understanding is being able to represent mathematical situations in different ways and knowing how different representations can be useful for different purposes (*Adding It Up, 2001, p. 119*).

Note:

Students often understand before they can verbalize their understanding. The degree of students' conceptual understanding is related to the richness and extent of the connections they have made.

STRAND 2: PROCEDURAL FLUENCY

Students have skill in carrying out procedures flexibly, accurately, efficiently, and appropriately (Adding It Up, 2001, p.116).

Productive Practices:

Students should be able to use a variety of mental strategies. Clearly connected with procedural fluency is the ability to estimate the result of a procedure and to flexibly use various solution methods while reflecting on which procedures work best for a given situation. Students should also be able to determine whether or not a specific method generalizes to a broad class of problems. Procedures should not be taught in isolation without student understanding of why they work. For example, students should not be taught to "add the opposite" when working with rational numbers without also having time to explore representations on number lines and/or use integer chips to develop an understanding of why "add the opposite" works.

Guiding Questions:

1. Teacher asked students, "Why does that procedure work?"
2. Can students explain what they are learning during a lesson and how it connects to other topics in math?
3. Are students using a variety of efficient procedural methods depending on the context of the problem?

Unproductive Practices:

There are a variety of practices that are detrimental or unproductive for students developing procedural fluency. Measuring student progress with questions that give false positives. These are questions that lead the teacher to believe the student understands the content when the student does not. Multiple choice questions and solely computational problems often give these false positives. The use of timed math fact tests has also been shown to be detrimental to students understanding, enjoyment, and progress towards procedural fluency. Being able to accurately and efficiently produce solutions to math facts is crucial to a student's development but it must be done through conceptual understanding to have a lasting impact. The use of shortcuts, tricks, and worksheets that focus on getting the correct answer, and the sole use of direct instruction are other unproductive practices with respect to procedural fluency.

Measures:

Student work samples. Student work shows that the standard algorithms are not the only methods being used. Assessments that ask students to model thinking but not asking them to model a specific method. Students clearly know that a variety of strategies are acceptable and expected.

STRAND 3: STRATEGIC COMPETENCE

Strategic competence is defined as a student's ability to formulate, represent, and solve mathematical problems (Adding It Up, 2001, p.116).

Productive Practices:

Students are regularly solving routine and non-routine problems for which a solution path is not immediately apparent. Students will have regular opportunities to come up with a variety of approaches to solving non-routine problems. Students will choose flexibly among effective methods to suit the demands presented by the problem.

Guiding Questions:

1. Are students regularly working on authentic problems that do not have an obvious solution pathway?
2. Do teachers provide individual time for students to solve problems prior to explaining the solution pathway?
3. Are lessons using rich tasks that provide student access to grade level content?
4. Can students verbalize their solution methods and are they given opportunities to do so?

Unproductive Practices:

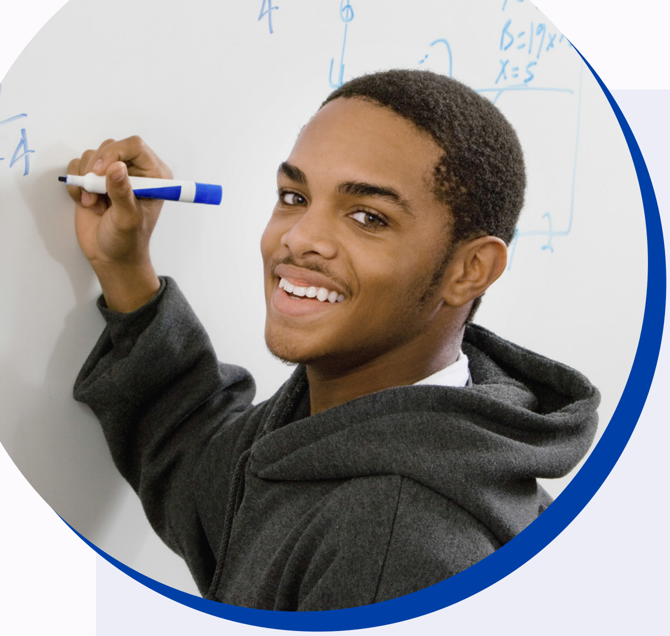
The quick recitation of the standard algorithm or other teacher lead procedure. Over reliance on key word strategies such as CUBE, PEMDAS, and SOHCAHTOA. Assessments that prescribe the tool or strategy that should be used.

Measures:

Student work samples. Assessments that are tied to learning goals. Tasks and assessments that have varied DOK levels.

Note:

Strategic competence is vital for our students' future. This is the skill that will allow them to be prepared for the ever-changing workforce they are entering after high school or college.



STRAND 4: ADAPTIVE REASONING

Students' capacity to think logically about the relationships among concepts and situations (Adding It Up, 2001, p. 129).

Productive Practices:

Students show reasoning that is valid stemming from careful consideration of alternatives. Students regularly have opportunities to justify their mathematical thinking and make them clear to others. Students listen carefully and critique the reasoning of other students using examples to support or counter examples to refute arguments (Standards for Mathematical Practice, 2010).

Guiding Questions:

1. Do students regularly participate in error analysis or discuss the reasoning involved in completed solution pathways?
2. Is student voice evident during lessons?
3. Are students active participants in classroom discussion?
4. Do students wait for the teacher to acknowledge they are correct or do fellow students play that role?

Unproductive Practices:

Students are shown and expected to reproduce a singular solution method or pathway. There is a classroom focus on answers rather than the process.

Measures:

Student work samples, observation of student thinking and classroom interactions. A suggested rubric can be found in Principles to Action (NCTM, 2014) on page 32 by referencing the column labeled "Explaining mathematical thinking."

Levels of classroom discourse rubric; Principles to Actions, NCTM 2014

STRAND 5: PRODUCTIVE DISPOSITION

Students have a tendency to see sense in mathematics, to perceive it as both useful and worthwhile, to believe that steady effort in learning mathematics pays off, and to see oneself as an effective learner and doer of mathematics (Adding It Up, 2001, p. 131).

Productive Practices:

Students explain their understanding of mathematical situations and make sense of problems. Students see themselves as mathematicians and productive members of the math classroom. Students regularly help one another better understand the mathematics and solution pathways. Students reflect on mistakes and misconceptions to improve their mathematical understanding. Students consistently demonstrate the effort necessary to continually improve and this effort is grounded in the belief that they can be successful doers of mathematics.

Guiding Questions:

1. Who is making sense of mathematics during the lesson?
2. Are students engaged through effort and positive/productive interactions with the teacher and peers?
3. Do students believe that math is useful and that they can succeed as learners of mathematics?
4. Are students regularly given opportunities to learn from the mistakes and misconceptions, to revise solutions, and/or to re-engage with their own mathematical thinking?

Unproductive Practices:

The teacher is the primary person making sense of mathematics during the lesson. They are explaining the math that must be completed. Classroom conversations are initiated by the teacher and student responses are short. The lesson is dominated by teacher talk time and there are only teacher-generated questions during the lesson. The teacher spends the majority of the lesson telling students how to do and think about mathematics.

Measures:

Surveys of student beliefs, teacher observation of students. Student work showing revisions. A suggested rubric can be found in Principles to Action (NCTM, 2014) on page 32 by referencing the column labeled "Building student responsibility within the community."

Note:

We often see students not engaging with a task even after prompting and assistance. This is evidence of years of marginalization and an ingrained negative disposition towards math. Healthy relationships and a safe environment needs to be cultivated before we will see any significant student engagement.

REFERENCES

National Association of State Directors of Teacher Education and Certification, Model Code of Ethics for Educators, https://www.nasdtec.net/page/MCEE_Doc, 2015.

National Council of Supervisors of Mathematics, *It's Time: Themes and Imperatives for Mathematics Education*. Bloomington, IN: Solution Tree Press: NCSM 2014.

National Council of Teachers of Mathematics, Principles to Action: *Ensuring Mathematical Success for All*. Reston, Va.: NCTM, 2014.

National Research Council, *Adding It Up: Helping Children Learn Mathematics*. Washington D.C.: National Academy Press: Adding It Up, 2001.

Mathematics Assessment Project, "Teaching for Robust Understanding", TRU Framework. 2016; https://www.map.mathshell.org/trumath.php

TNTP.org, *The Opportunity Myth*. TNTP 2018; https://tntp.org/assets/documents/TNTP_The-Opportunity-Myth_Web.pdf; https://opportunitymyth.tntp.org/.

Wiliam, D. (2011). *Embedded formative assessment*. Bloomington, IN: Solution Tree Press.