What Research Says

The activities in this brochure which MC² refers to the following as "Instructional Strategies" fall under the umbrella of effective, research-based practices:

- ✓ **Cooperative Learning:**
  - Cooperative vs. Individual Effect Size[1] = .59 (Hattie[2])
  - Cooperative vs. Competitive Effect Size = .54 (Hattie)
  - In General: Effect Size = .73 (Marzano[3])
- ✓ **Classroom Discussion:** Effect Size = .82 (Hattie)

Examining research results helps teachers become more explicit in their instruction as they identify specific interventions. Marzano, Pickering and Pollock, as well as Hattie each conducted a meta analysis of instructional practices to determine which were the most effective for teaching and learning. Hattie identified that anything above an effect size of .40 has more of an impact than just a typical year of academic experience and student growth.

[1]Effect size expresses increase/decrease in achievement of experimental student group in standard deviation units.
[2]Hattie, John (2012). Visible Learning for Teachers: Maximizing Impact on Learning. Routledge, New York, NY.
[3]Marzano, Robert J., Pickering, Debra J., and Pollock, Jane E. (2001). Classroom Instruction that Works: Research-Based Strategies for Increasing Student Achievement. Association for Supervision and Curriculum Development (ASCD), Alexandria, VA.

Whole Class **Pairs** **Small Groups**

MC² is ...

- A partnership of educators including university mathematicians, district administrators and mathematics school teachers across the state of New Mexico.
- State and federally funded by New Mexico Public Education Department (PED) and Math-Science Partnership Program (MSP).

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Instructional Strategies That Enhance Student Engagement

Standards-Based Learning Environment (SBLE) Indicators

In response to teacher requests, MC² is sharing instructional strategies that many facilitators use while working in classrooms.

MC² Facilitators choose from the enclosed strategies to support the **Five SBLE Indicators** below, which through research have been shown to support student learning. The purpose is to choose a strategy that will enhance learning of the content and support the desired learning target.

1. The **enacted lesson provided** opportunities for students to make conjectures about mathematical ideas.
2. The **enacted lesson fostered** the development of conceptual understanding.
3. **Students explained** their responses or solution strategies.
4. Multiple perspectives/strategies were **encouraged and valued**.
5. The **teacher valued** students' statements about mathematics and **used** them to build discussion or work toward shared understanding for the class.

Adapted from: Tarr, J.E., Reys, R.E., Reys, B.J. & Chávez. O. (2008). "The Impact of Middle-Grades Mathematics Curricula and the Classroom Learning Environment on Student Achievement." Journal for Research in Mathematics Education, Vol. 39, No. 3, pg. 247-280.

Contents

MC² Thinking Protocol (15-20 min.)

1. Think individually about the task and the three questions below using a certain colored writing utensil. **(3 min.)**
   - ✓ What do I know about the problem?
   - ✓ What questions do I have?
   - ✓ Explain your reasoning or thinking in solving the problem.
2. Think with a partner about the problem. Use different colored writing utensils to add to the solution. Don't erase from your original ideas. **(5 min.)**
   - ✓ Discuss your thinking about the questions with your partner. Make sure both partners have a chance to share. You may add to your thinking or change your thinking with the different color.
3. Share strategies for solving the problem as a whole group. **(6 min.)**
   - ✓ Teacher selects 2-3 students or partners to share their ideas. The purpose is to add new ideas/ strategies to the whole group's thinking.
4. Ask students to reflect on the problem and identify what was easy/hard about the problem. **(1 min.)**

Created by: Mathematically Connected Communities (MC²)

Agree or Disagree

- Teacher poses a question/problem for students' think time.
- Teacher asks students to agree or disagree with a possible answer.
- Students are asked to think about the answer for one minute.
- Students defend their answer or clarify why the answer is correct or incorrect.

Adapted from: Classroom Discussions: Using Math Talk To Help Students Learn, Grades 1–6 © 2003 Math Solutions Publication

Wait, Wait, Wait

- Teacher poses a question/problem and all students think and wait.
- Teacher waits after asking a question and **ALSO** after a student responds to allow that student to add to response.
- Teacher then calls on other students to answer.
- If the answers are conflicting, teacher decides whether to leave problem in *parking lot* to think about or initiates a discussion later to clarify the misconceptions.

Created by: Mathematically Connected Communities (MC²)

Pause, Paraphrase, Probe, Inquire (PPPI)

Pause: Pausing before responding or asking a question allows time for thinking and enhances dialogue, discussion, and decision-making.

Paraphrase: Use a paraphrase starter such as:
- So…
- As you are…
- You're thinking…
- If I understood correctly…..

Following the starter with an efficient paraphrase assists members of the group in hearing and understanding one another as they converse and make decisions.

Probe/Inquire: Using gentle, open-ended probes or inquiries such as the following, to increase the clarity and precision of the group's thinking:
- Please say more about…
- I'm curious about…
- I'd like to hear more about…
- Then, are you saying…?

Adapted from: The Seven Norms of Collaboration; Garmston, R., and Wellman, B. (2009) The Adaptive School: A Sourcebook for Developing Collaborative Groups, 2nd edition. Norwood, MA: Christopher Gordon.

Sentence Starters/Frames

Create sentence starters/frames to provide the structure or partial structure to help students describe their work and/or thinking to group. Post these around the classroom.

Sample Sentence Starters for Math Practice 3:

- I made a conjecture when I…
- I justified my conclusion by…
- I constructed a viable argument when…
- I made sense of another's argument when I …
- A question I asked to help clarify my own or someone else's thinking was…

Sample Sentence Frames for Math Practice 4:

- The important quantities in this problem are ____ because ___.
- I estimate the answer to be ____ because ____.
- I decided to represent the problem by (table, equation, graph, diagram, flow-chart, formula, etc.) ____ because ____.
- The equation I used to represent the problem matches my mathematical thinking because ____.
- I changed my strategy when ____.

Sample Sentence Starters/Frames for CCSS Mathematical Practices
created by: Mathematically Connected Communities (MC^2).

Inside Outside Circle

This process promotes collaboration among students by enabling each one to hear the answer to a question many times while also listening to various other questions.

- Teacher prepares a set of cards with questions on one side and answers on the other.
- Students are divided into two groups.
  - One is the *inside circle* facing out.
  - Other group is the surrounding *outside circle* facing in.
  - A student from the *outside circle* pairs with a student from the *inside circle* and they face each other.
- *Outside circle* students show the problem on the card to their *inside circle* partner.
- *Inside circle* partner offers an answer, *outside circle* partner agrees or asks a guiding question (refrain from saying "No" and providing answer).
- Process repeats with *inside circle* person showing his/her card to *outside circle* partner.
- *Outside circle* rotates two students to right and process begins again.

Adapted from: Kagan, S. and Kagan, M. (1998). Multiple intelligences: The Complete MI book. San Clemente, CA.

Match Mine

This is a process for strengthening mathematical concepts using math vocabulary with depth and clarity. Begin by placing a divider between each pair of students to obscure their view of their partner's card.

For Solving Problems

- Student A selects a card with a math problem displayed and is the only one to see the card.
- Student A describes the problem and steps for solving it to Student B.
- Student B reproduces the problem and solution on a piece of paper.
- Student B reveals work to Student A.
- Pair checks for misconceptions.

For Geometric Shapes

- Student A selects a card with a geometric picture displayed and is the only one to see the card.
- Student A describes how to draw the shape to Student B without naming the shape.
- At the end, students agree on a name for the shape (quadrilateral, rectangle, etc.)

Continue the activity by having students switch roles.

Adapted from: Kagan, S. and Kagan, M. (1998). Multiple intelligences: The Complete MI book. San Clemente, CA.

Peer Coaching

- Teacher prepares a set of 4-5 math problems per student on the same content, all on same page.

Student A	Student B

- Teacher pairs up students and provides only one pencil per pair.
- Student A works a problem, verbally explaining steps to Student B.
- Student B asks guiding questions to assist Student A if incorrect.
- Students switch roles and continue process.
- Teacher rotates among students listening for mathematical vocabulary, correct process, and misconceptions.
- If all problems are not completed during class, teacher has the option of cutting paper down middle to send home for homework.

Adapted from:

- Silver, Harvey F (2012) Math Tools, Grades 3-12: 60+ Ways to Build Mathematical Practices, Differentiate Instruction, and Increase Student Engagement. Corwin, A Sage Company, pg. 177.
- Kagan, S. and Kagan, M. (1998). Multiple Intelligences: The Complete MI book. San Clemente, CA.

Poster, Present, and Defend

This activity may be used when the teacher wants all students to develop deep understanding of a particular mathematical concept. Interdependence is developed due to the fact that all students must know the math.

- Teacher poses the problem.
- Teacher discusses group roles.
- Students decide which of the following group roles they will take:
  - Student #1 draws/scribes the poster.
  - Student #2 presents the poster to the class.
  - Student #3 answers questions about the work on the poster.
- In groups of 3 or 4, students solve, model, and verbalize their solution and/or process.
- Teacher may decide during presentations if she wants other team members to clarify or add-on any information.

Created by: Mathematically Connected Communities (MC^2).

Send Out a Scout/Spy

This activity may be used:

- When the group is not able to move forward with solving the problem or is going down a wrong path.
  - Teacher appoints one student from each group to go out and scout/spy to bring back information to the group.
  - An alternate method is for a whole group who is struggling to send out all members to scout/spy on other groups and then come to consensus with their original group on how to proceed.
- When teacher sees similarities in different groups, a scout/spy may be sent out to bolster confidence and re-enforce strategies.
- To give one student voice, teacher may make him/her the scout/spy, thus creating a need for the other group to listen to this voice.

Adapted from: One Stray, Kagan, S. and Kagan, M. (1998). Multiple intelligences: The Complete MI book. San Clemente, CA.

Stand-Up, Hand-Up, Pair Up

This may be used as a team-builder or for review of content.

- Teacher poses either a content or personal question.
- Students think of an answer for one minute.
- Teacher plays music while students rotate around room with one hand up in the air.
- When music stops, students pair up with a partner.
- Note: Hands that are still up need a partner.
- One partner shares for one minute.
- Then other partner shares for one minute.
- Teacher rotates among pairs listening and asking clarifying questions.
- Replay the music and repeat the process.

Adapted from: Kagan, S. and Kagan, M. (1998). Multiple intelligences: The Complete MI book. San Clemente, CA.

The Huddle

- Teacher calls a "Huddle".
- One pre-appointed student* from each group comes to huddle with the teacher.
- Teacher shares a possible strategy to use to help solve the problem.
- Students may ask one question.
- Students return to their groups to share the strategy.

*This is a good opportunity to help *elevate the status* of the chosen student who may be quiet or is not listened to often.

Adapted from: Simpson, Virginia. Lenses on Learning

Think Pair Share

Assign Pairs.

- Pose question/problem.
- 2 minutes to think alone (to ensure student's thinking time).
- Based on problem, students engage in written or mental think time.
- Partner A shares -1 minute.
- Partner B shares - 1 minute.

Optional: Partners agree on what to share with whole group

Lymna, F. (1981). "The Responsive Classroom Discussion." In Anderson, A. S. (Ed.), Mainstreaming Digest, College Park, MD: University of Maryland College of Education.