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MOMENTUM FOR MATH

HELP STUDENTS BECOME ACTIVE LEARNING PARTNERS IN ONLINE CLASSROOMS

BY SUE CHAPMAN AND MARY MITCHELL

Peek into a math classroom, virtual or physical. What are students doing and saying about their math learning? Are they engaged? Are they thinking critically — evaluating solutions, assessing their understanding, revising their strategies, explaining concepts, and connecting mathematics to real life?

According to the National Council of Teachers of Mathematics, "When students take an active part in monitoring and regulating their learning, then the rate of their learning is dramatically increased" (2007). The meta-cognitive abilities to think about what they currently know and don't yet understand and the skills of setting learning goals and monitoring progress toward achieving these goals are vital to students' success today and tomorrow.

Helping all students become more self-directed in their mathematics learning is especially necessary in the online environment in which we find ourselves today. To be successful in a virtual learning environment, students must learn how to deal with distractions and manage time. They must develop the skills of recognizing and signaling when they need support. They also need a tool kit for self-scaffolding — strategies, tools, and human resources they can draw from when learning becomes challenging.

Building these skills is an equity issue. In her book *Culturally Responsive Teaching & the Brain*, Zaretta

Hammond tells us that "many culturally and linguistically diverse students are 'dependent learners.' " They haven't yet developed the skills needed to "facilitate their cognitive growth" and "activate their own neuroplasticity" (Hammond, 2015, p. 14). At a time when inequities are more pronounced and concerning than ever, helping students learn how to "accelerate their own learning, meaning they know how to learn new content and improve their weak skills on their own" is an important equity strategy (p. 15).

Although many of the strategies for fostering self-directed learning are similar in physical and virtual classrooms, there are some differences to consider and plan for. Below are some concrete ways to help students grow these learning proficiencies in virtual classrooms as well as or instead of physical ones.

WHAT SELF-DIRECTED LEARNING LOOKS LIKE

Self-directed learners adopt and maintain a learning stance toward challenges that are a natural part of all types of learning. They are reflective, self-aware, and equipped with strategies for learning more. The box at right lists specific student competencies for self-directed math learning.

If students are to become self-directed math learners, we must invest class time — whether in person or online — in explicitly teaching the skills of self-directed mathematics learning. Each of the competencies in the list can be introduced to students in a minilesson and then reinforced as students engage in math learning activities. For an example of a minilesson on the student competency "I can use strategies to persevere with challenging problems," see the PDF version of this article on Learning Forward's website at **learningforward.org/the-learning-professional.**

We also need to provide opportunities for students to practice these new skills and receive feedback. Many of the actions that we recommend teachers take can occur regardless of physical location (see the table on p. 32). Certain actions, like facilitating peer feedback, may require an additional step of setting up a process for connecting online, but the task does not change fundamentally.

SELF-DIRECTED LEARNING IN ONLINE ENVIRONMENTS

While these processes can happen online or in person, there are some specific considerations for promoting self-directed learning in an online environment. The table on p. 33 identifies three challenges to facilitating math learning online and offers strategies for addressing these challenges.

SELF-DIRECTED LEARNING IN ACTION

For an example of how to facilitate self-directed learning in math during remote learning, take a look inside this hypothetical virtual 3rd-grade class as the students learn about measurement concepts and procedures. (This vignette is a composite of multiple experiences in online classrooms we have worked with.)

After greeting her students and welcoming them to their online class session in Google Meet, Grace Sun reminds her 3rd-grade students to

PARTIAL LIST OF STUDENT COMPETENCIES FOR SELF-DIRECTED LEARNING OF MATHEMATICS

- I can use math vocabulary to explain my math thinking.
- I can ask questions if I don't understand.
- I can ask for help if I need it.
- I can restate another student's idea.
- I can use different strategies to solve problems.
- I can work independently.
- I can work collaboratively.
- I can represent my math thinking visually.
- I can use strategies to persevere with challenging problems.
- I can prove my answers make sense.
- I can learn from my mistakes.
- I can use feedback from others to improve my math work.
- I can set goals for my math learning and track my progress.
- I can reflect on my math learning.
- I can explain what I need to know and be able to do on assignments.
- I can use my math journal as a learning tool.

EXAMPLES OF TEACHER ACTIONS TO PROMOTE SELF-DIRECTED LEARNING IN MATHEMATICS	
Teacher actions to help students take ownership of their learning	• Provide clear learning targets and success criteria. Allow students to set personal goals in support of these learning targets. • Have students collaborate in developing "I can" statements, checklists, rubrics, and other tools that build understanding of success criteria and allow students to track their progress. • Help students set up and learn to use a personal glossary of math vocabulary they can refer to in writing explanations of their math thinking. • Use menus of learning options to give students choice in how to achieve learning targets. • Select or design mathematics tasks that allow students to use multiple approaches, explain their math thinking, and make connections. • Give students opportunities to apply mathematics to real-world problems that are relevant to their lives.
Teacher actions to help students use feedback to strengthen their learning	• Provide opportunities for students to revise their mathematics work based on feedback. • Teach students how to give actional feedback to each other. Actionable feedback describes in specific terms how the work meets success criteria and how it can be improved. • Use protocols for giving feedback such as Two Stars and a Wish, in which students make two positive comments and one suggestion about a peer's work.
Teacher actions to help students articulate what they are learning and why it is important	• Have students solve the same problem at the beginning and end of a unit and then compare the two pieces of work. • Have students keep work portfolios that include written work samples as well as photos and video artifacts that demonstrate learning. • Invest time in brief check-in meetings with students and student-led parent conferences. • Have students keep a math autobiography as a tool to reflect on their math learning over time and reinforce their identities as developing mathematicians.

upload a photo or Google doc of yesterday's math homework to their Google Classroom site.

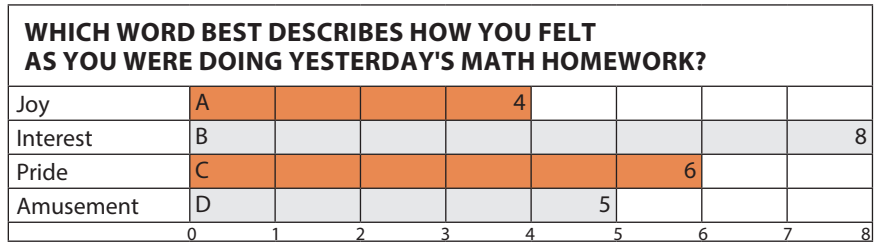
The homework assignment read: "Choose an object in your home to measure in as many ways as you can. You may use nonstandard measurement tools as well as standard measurement tools. Record your measurements. Remember that each measurement must include a number and the unit of measure. Answer the following questions: 1) What are you learning about measurement? 2) What is one question you have about measurement?"

Sun presents a quick poll using Poll Everywhere to spark reflection about their learning. She asks: "Which word best describes how you felt as you were doing yesterday's math homework?"

She shares the poll results above.

As the class reviews the poll results, students are invited to share noticings and wonderings related to the data.

Later in the day, Sun will review students' homework and design additional learning experiences based on their questions and interests as well as what their work reveals about their understandings related to measurement.



Next, Sun talks to her students about their upcoming student-led conferences with parents and the roles they will play. She has scheduled a 15-minute virtual session with each student and a parent or caregiver to celebrate students' accomplishments and keep parents informed about students' next steps in learning.

Sun has seen how these brief conferences reinforce students' ownership of their math learning and their identities as math learners. They also allow parents to experience the same technology-supported learning tools that children are using. Sun is convinced that these conferences strengthen her partnership with families.

During the conferences, students will share a progress chart showing their growth toward learning targets and a piece of problem-solving work they have chosen from their digital portfolio stored in a Google folder. Referring to success criteria that the class developed together, students will explain how the work demonstrates their learning. Finally, students will share a personal learning goal they will work toward during the upcoming unit on fraction concepts.

MEETING THE CHALLENGE OF FACILITATING MATH LEARNING ONLINE

ONLINE CHALLENGE	STRATEGIES TO ADDRESS CHALLENGE
FORMATIVE ASSESSMENT Teachers do not have access to the wealth of learning data that can be gathered through face-to-face observation of students. As a result, teachers need to be even more intentional about monitoring students' math understandings and mindsets when teaching online. They also need to develop new formative assessment strategies and routines.	• Do a quick check-in with students after each chunk of learning. For example, using emojis, respond to the following questions in the chat window: 1. I understand the ideas we just talked about. 2. I feel confident about my learning. • During each online class session, identify one student to observe. After the session ends, take a few minutes to jot down anecdotal notes about evidence of the student's engagement in learning (Knight, 2019): o Behavioral engagement: Did the student participate in class activities? Were there distractions in the home environment the student had to contend with? Is the student turning in assignments and, if not, what are some possible reasons? o Cognitive engagement: Did the student show evidence of thinking about learning activities? Is the student making learning connections? If not, what scaffolding might be needed? o Emotional engagement: Does the student feel safe to share math thinking with the class? Does the student appear to feel connected to the class and positive about the learning experience? If not, what forms of personal contact might be needed?
CLASSROOM DISCOURSE Facilitating online discussions is challenging because nonverbal cues are not readily available, and virtual classrooms don't offer easy options for partner talk. Teachers need to develop new discussion protocols to allow for equitable participation in small-group and whole-class discussions.	• Include response activities that allow all students to share their thinking without extensive talking or writing, like sentence frames or questions requiring one-word responses. • Instead of partner talk as preparation for whole-class discussion, pose an open-ended question as a journaling assignment for homework. Begin the next class session with a discussion of this same question. • Use breakout groups or schedule small-group sessions for students to work collaboratively on problem-solving tasks. This is an excellent time to listen in and provide feedback related to one of the student competencies for self-directed learning.
MANIPULATIVE MODELS Most students don't have access to the manipulatives and mathematical tools available in face-to-face classrooms. Teachers need to think creatively about ways to allow students to see and represent mathematical ideas in concrete and pictorial forms.	• Free sources of virtual manipulatives are readily available. Remember that students need opportunities for free exploration of virtual and concrete manipulatives before using them as learning tools. • Teachers can guide students through the process of creating a needed manipulative (e.g. ten frame, ruler, fraction model) as a learning experience. • At the start of the next school year, provide students with a set of math manipulatives to keep at home for use with homework and in case learning must transition back online.

Sun expects students to do most of the talking during the conferences, but she has a few questions ready to offer if needed, including the following:

- How is learning math in an online classroom similar and different from learning in our regular classroom?
- How are you becoming more self-directed in your learning because of your experiences learning online?

Students will respond to these

MATH PROBLEM

- Chris and Viktor found a broken ruler and decided to use it to measure some objects.
- First, they measured a pair of scissors.
- Chris said the scissors were about 10 inches long.
- Viktor said the scissors were about 8 inches long.
- Who is right? How do you know?

reflection prompts in their math journals before their conferences. They will also practice talking about their learning with a classmate in a breakout room before the actual conference.

Next, Sun works through a math problem (on p. 33) with the students.

Students use the hand-raising tool in Google Meet to show that they would like to share their thinking. Nakia turns on her mic and begins the discussion, stating that she agrees with Viktor because the tip of the scissors is near 2 and the edge of the handle is near 10. The difference between 2 and 10, Nakia explains, is 8.

Sun asks students to indicate whether they agree or disagree with Nakia using a thumbs-up or thumbs-down signal. Some students agree, but others are not sure, and a few disagree. Sun asks whether someone can represent Nakia's strategy on the virtual white board.

Arthur draws a number line and shows eight individual jumps between the numbers 2 through 10. Sandra adds on by representing the problem with the equation 2+8=10. Students debate whether the ends of the scissors fall precisely at 2 and 8, leading to a discussion of what it means to be "about 8 inches long."

Sun wants to identify students who do not yet have full understanding of the measurement concepts behind this task. These students will participate in an online guided math lesson tomorrow. Knowing that all students need practice articulating their math thinking, Sun asks students to explain and justify the answer they believe is correct in their online math journals.

As students are writing, Sun sets up breakout rooms in Google Meet for the next part of the lesson. She introduces the math task above and then sends students to breakout rooms to work together.

Sun checks in on each of the breakout groups. When she sees that a group has a plan for its investigation, she helps the group brainstorm some tools they might find at home to measure a minute. They come up with the following ideas: a clock or watch with a second hand, cell phone, a timer on the microwave, even a sibling or a parent counting "one thousand one …" up to 60 seconds.

JUMPING JACKS MATH TASK

1. How many jumping jacks can our whole class do in one minute? Make an estimate.
2. Compare and discuss your estimates with your group.
3. Talk about some ways you might gather data to help answer this question. Record your plan here.
4. Your homework for tonight is to gather data to help solve this problem.
5. Tomorrow you will share the data you collect with your group and prepare to present your investigation findings to the class.
6. Be ready to talk about what this investigation has to do with measurement.

As she closes the session, Sun challenges students to think about some ways they might use measurement over the next week to help family members. She ends class with this send-off: "See you tomorrow, mathematicians."

In this lesson, Sun leverages technology to use many of the same strategies for self-directed math learning she would use in a physical classroom. But she also builds in scaffolds that are particularly needed in an online environment, like the preparation for the student-led conferences. As a result, her students develop the skills they need for learning in this setting — and any other.

EXPANDING OUR GOALS

Teaching for self-directed math learning is more important now than ever. It sets students up for success in future math learning settings — whatever they might look like — and in life. Math education leaders Jeane Joyner and Mari Muri write, "The emphasis on students taking increased responsibility and becoming more engaged in assessing their own work is not an abdication of our responsibilities as teachers. Rather, we are expanding our goals for teaching and learning mathematics to include more emphasis on student metacognition and the development of work habits that will become lifelong skills for our students (Joyner & Muri, 2011, p. 168)."

Students learn more when they become active partners in their own math learning. Even more important, the skills they acquire along the way equip them to thrive in a changing world and prepare them for whatever the future holds.

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