# BUILDING CONFIDENT AND MOTIVATED MATH LEARNERS: A CLASSROOM STRATEGIES HANDBOOK

A PRACTICAL GUIDE FOR HIGH SCHOOL MATH TEACHERS TO BOOST STUDENT CONFIDENCE, MOTIVATION, AND ENGAGEMENT THROUGH TESTED STRATEGIES AND CLASSROOM INSIGHTS.

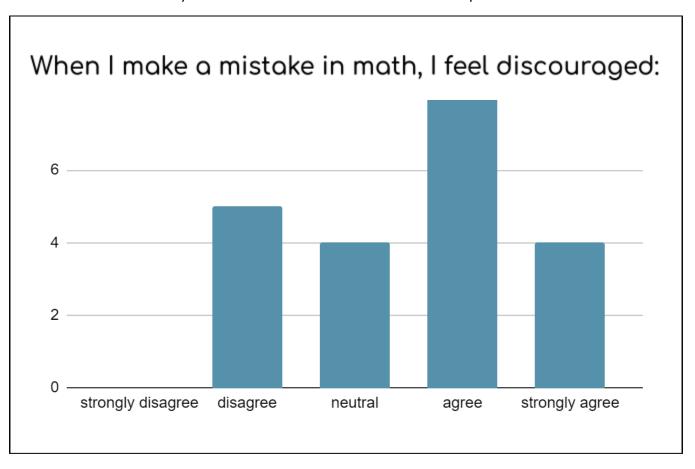
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# **OUR WHY**

Here is a survey of a group of 20-2 students from September, 2024. Students were asked how they feel about math. The results of one question are below:



The responses showed that students consistently feel discouraged when they make mistakes in math. This sparked our interest in figuring out how we can help eliminate this feeling in high school math classrooms. Ultimately, we decided that the way instruction is delivered would have the most influence on this.

To effectively change the way students perceive and respond to mistakes in math, we wanted to incorporate a variety of instructional strategies during our practicum placements. Our hope was that these strategies would help shift the focus away from fear and discouragement, and move students towards a growth mindset. We have compiled and rated our strategies in this booklet.

# Strategy 1: Vertical Whiteboard Surfaces

### What the strategy is:

Vertical whiteboard surfaces encourage students to collaborate in small groups while solving math problems. There is only one whiteboard marker per group, and the person who is writing cannot be the person talking. The idea is to have the students work at whiteboards placed at different spots around the classroom, allowing them to physically engage with the problems while discussing their solutions with peers. Having their work be less concrete and easier to erase gives them the freedom to take more risks. Students are able to look around the room at the work of others to help them with their next step when they are stuck. This strategy also helps the teacher see the work of all students.

#### How we implemented the strategy:

The classrooms we were in had whiteboards all over the class. We assigned each group of students a whiteboard to work on. They were given a set of problems that encouraged critical thinking and discussion, such as open-ended questions or real-world problems. We rotated groups so that every student worked with different peers throughout the semester. Sometimes the groups were selected randomly, and sometimes they were given the option to choose their own.

# How we would suggest others implement it in the future:

We suggest starting with easy, low-stakes problems to ease students into this strategy. As they grow more comfortable, gradually introduce more complex tasks. Encourage students to explain their thinking to their peers to strengthen communication skills and deepen understanding. It is beneficial to start this strategy right at the beginning of the course so that students accept that it will be a routine thing. It is also crucial to enforce the one marker per group rule, and circulate to ensure it is not just one person working.

- Student Engagement: Students reported feeling more engaged with the material when using the vertical whiteboards, they started asking to use them each class.
- Student Confidence: Both survey results, and discussions with students showed increased confidence in their ability to solve math problems after using the whiteboards in groups.
- Motivation: Through observations, we both felt that motivation was higher in students who participated in this activity regularly.

#### Personal Reflections and Rating:

We found that the vertical whiteboards were an excellent way to foster collaboration and help students see different problem-solving approaches. The physical movement and active participation seemed to enhance engagement and break down barriers in a subject that some students find intimidating.

Rating: 5/5



# Strategy 2: Bell Ringers

#### What the strategy is:

Bell ringer problems are short, math problems given at the start of class. These problems are designed to activate prior knowledge and warm up the brain, helping students get into the mindset of problem-solving from the start of class.

#### How we implemented the strategy:

Almost each day, we posted a bell ringer problem on the board that either required students to apply previously learned concepts, or required them to think creatively. We gave them 5–10 minutes to work on the problem, then discussed the solution as a class. Sometimes they were instructed to work individually on paper, other times in groups of 2-3 either on paper or on whiteboards.

# How we would suggest others implement it in the future:

To keep students engaged, vary the types of problems (e.g., real-world scenarios, puzzles, or problems with multiple solutions). Examples of some activities we used can be found in the "Strategy 3" section below. The questions used during this time can be used to review topics from the previous lessons, prepare for upcoming summative assessments, or just encourage critical thinking. This would be a time to use "Number Talks" if you were wanting to. No matter what type of problem, it is important to allow students to discuss their approach with a partner before the class discussion to build confidence in their problem-solving process. Aim to hear from each student in your class through the week.

- Student Engagement: Students shared that they liked starting class with a bell ringer because it helped them transition into learning mode.
- Student Confidence: Students said they felt more confident tackling problems in the lesson after doing bell ringers that related to that day's topic. Throughout the semester they got more and more willing to share their reasoning.
- Motivation: Bell ringers help students ease into class. We both noticed that students would struggle with our first learning activity on days we did not start with a bell ringer.

# Personal Reflections and Rating:

While the bell ringer was effective in preparing students for the lesson, we noticed that some students found the problems too challenging at first. We would recommend differentiating the difficulty level or providing hints for students who struggle. Overall, we loved how effective bell ringers were in getting students ready for class.

Rating: 4.5/5



# Strategy 3: Critical Thinking Problems

#### What the strategy is:

Critical thinking problems are meant to be open-ended in order to invoke higher-level thinking. The problems typically have an accessible entry point (low floor), but room for a challenge (high ceiling). Students can work on them individually or in groups, as long as they are providing reasoning for their way of thinking. Some examples of these problems are the ones found on the NRICH website (https://nrich.maths.org/), designed to develop critical thinking and problem-solving skills. These problems often have multiple solutions and require students to explore various approaches. Algebra word problems can also be used to engage students in critical thinking. Other quicker critical thinking tasks include "Which One Doesn't Belong" or "Esti-Mystery" tasks.

# How we implemented the strategy:

We found the best way to implement these types of problems was to use them as our bell ringers a couple of times a week. Framing the problems as class challenges was helpful, as the students would get excited about them. Students worked individually or in small groups to solve the problems, and we debriefed as a class afterward, discussing the different strategies they used.

# How we would suggest others implement it in the future:

Teachers should introduce nrich problems or other more complicated problems with scaffolding to support students, especially those who are less confident in their problem-solving abilities. The first few problems that are introduced in the course should be done in groups so that students get used to brainstorming and critical thinking. Provide time for exploration and allow students to work collaboratively often, as the problems typically require deep thinking and can take longer. Always ensure that students share their justification for their answer(s).

- Student Engagement: Students got invested in the more involved problems, and loved feeling challenged, but then successful.
- Student Confidence: Students expressed that they felt more confident in their ability to solve complex problems after completing NRICH tasks and algebra word problems.
- Motivation: The variety of problems made math feel more interesting, and encouraged students to work hard at them.

### Personal Reflections and Rating:

While these problems were great for building critical thinking, some students were initially frustrated by the open-ended nature of the problems. Over time, they adapted and started to appreciate the challenge. These problems are useful for engaging and challenging students.

Rating: 4.5/5



# Strategy 4: Random Group Work

#### What the strategy is:

In this strategy, students are randomly assigned to different groups each class, ensuring that they collaborate with a variety of classmates. This helps build new relationships and allows students to benefit from different perspectives on problem-solving. Some examples of how groups could be chosen are playing cards, an online name generator, or passing out different objects. Typically groups of 3 are most effective for collaborative work.

#### How we implemented the strategy:

We used an online tool ("Flippity") or playing cards to randomly assign students to groups for different activities and projects. The goal was to mix up groups frequently to allow for new interactions and learning opportunities.

# How we would suggest others implement it in the future:

We suggest that teachers use group work for as many activities as possible. When using vertical surfaces, random groups are effective. Be sure to check in on group dynamics and provide students with clear instructions and guidelines for collaboration to ensure that all voices are heard. When students are in their random groups at vertical whiteboards, they can be changed easily by numbering them off 1-3 and then having the 1's move one spot and the 2's move 2 spots (creating all new groups). It is important that if random groups are going to be used, they must be used from the beginning of the course. Attitudes toward random groups were better in the classes where it is implemented at the beginning.

- Student Engagement: Most students said that they enjoyed working with different peers and learning new perspectives. We noticed that when students were not distracted by their friends they were more on task and engaged.
- Student Confidence: Random groups create a wider spread of skill within the groups, but then students help each other, and eventually gain confidence..
- Motivation: Motivation was mixed, as although many enjoyed working in groups, some were not willing to work with those they were not friends with. Once random groups are implemented in the classroom, the reward of being allowed to choose your own groups can be used as a motivating factor.

#### Personal Reflections and Rating:

While the random groups worked well for the majority of students, some students preferred working with the same peers. It can be helpful to have a balance between random groupings and allowing students to select their own groups. We loved that when students worked in random groups, the groups worked at a more similar pace (there was not one group that finished way ahead or way behind).

Rating: 4/5



# Strategy 5: Collaborative Learning/Peer Teaching

#### What the strategy is:

Collaborative learning and peer teaching involve students working together to explore concepts, solve problems, and teach each other. This method emphasizes teamwork, shared responsibility, and the exchange of ideas, fostering a supportive environment where mistakes are normalized and learning from them is encouraged.

#### How we implemented the strategy:

We structured our classroom activities to include think-pair-share exercises, group problem-solving tasks, and peer teaching opportunities. Students were paired or grouped to work on problems collaboratively and then present their solutions to the class. This peer teaching approach encouraged students to articulate their reasoning, explain their mistakes, and learn from their peers' insights. We would also use elbow buddy examples during our notes. Another way we promoted collaboration in the classroom was during unit exams. We allowed students 5 minutes to look through the test with their peers (they were not allowed to write anything down). Many students took advantage of this time to go talk with their peers, and brainstorm problem-solving approaches.

#### How we would suggest others implement it in the future:

Start by establishing clear roles and expectations for group work to ensure balanced participation. When students are working together, encourage them to discuss common mistakes and successful strategies. Provide guiding questions to keep group discussions focused and productive. If students are seeming too shy to share, give them a chance to discuss with others first, and then ask for responses.

- Student Engagement: Students were more engaged during notes when they knew
  that they would have chances to discuss and practice with each before having to
  share with the class. Students expressed they felt more engaged during
  collaborative activities, finding it more fun than solo work.
- Student Confidence: Students said they felt more confident tackling difficult problems on their own, after having the chance to go over their thought process and receive peer feedback first.
- Motivation: When students know that their peers are relying on them, it requires them to contribute and work harder.

# Personal Reflections and Rating:

Collaborative learning and peer teaching were effective strategies for promoting deeper understanding and building a sense of community. Students benefited from hearing different approaches to problems and gained valuable communication skills. In the future, adding more structured reflection after group work could enhance learning outcomes.

Rating: 5/5



# Strategy 6: Formative Assessment and Feedback

# What the strategy is:

Formative assessment with feedback is an approach where students engage in low-stakes, ongoing assessments that provide immediate feedback. This strategy is designed to help students identify and learn from their mistakes early in the learning process, promoting growth and deeper understanding rather than focusing solely on grades.

#### How we implemented the strategy:

We used short quizzes, exit slips, and quick check-ins to assess students' understanding throughout the lessons. We also used vertical whiteboards as a way to formatively assess if students were understanding concepts. After these formative assessments, we provided feedback to students that highlighted specific errors and suggested strategies for improvement. We also encouraged students to review their mistakes and reflect on how to approach similar problems differently. Regular feedback allowed students to make corrections to their work to demonstrate their learning progress.

# How we would suggest others implement it in the future:

Integrate frequent, low-stakes assessments that are designed to find learning gaps without risk. After each assessment, provide constructive feedback (written or oral) that explains the mistake and guides students on how to correct it. Use class discussions or one-on-one meetings to review common mistakes and share problem-solving techniques. Encourage students to revise their work based on feedback and resubmit it to reinforce learning. Using the vertical surfaces to provide verbal feedback to the class, groups, or individuals, is a quick and effective way to deepen learning.

- Student Engagement: Students were eager to receive feedback to see if they were on the right track, so students were more engaged in activities.
- Student Confidence: Students noted that formative assessments helped build their confidence, as they could see their progress over time. They felt more confident in their skills, and also in preparing for summative (higher stakes) assessments.
- Motivation: Students told us that getting feedback right away made them want to continue to understand their mistakes and improve their work.

# Personal Reflections and Rating:

Formative assessment with feedback proved highly effective in reinforcing the idea that mistakes are part of learning. Students responded positively to the opportunity to learn from their work and receive support. We think there should be an emphasis on formative assessment and feedback for students in every classroom.

Rating: 5/5



# Strategy 7: Gamification

#### What the strategy is:

Gamification involves incorporating game elements such as points, challenges, and rewards into the learning environment to make the educational process more engaging. This also involves creating games to teach or practice concepts. This strategy is intended to increase student motivation and participation by tapping into the competitive and playful nature of games.

#### How we implemented the strategy:

We integrated game-based activities such as math competitions or challenges, factoring bingo and logical puzzles. We found that students got invested when there were prizes (candy) on the line. We also found that for the math challenges it was best to have students in teams so that they do not feel singled out if they lose.

#### How we would suggest others implement it in the future:

Begin by identifying key concepts that could benefit from gamified elements and decide on what game components would fit your classroom dynamic (point systems, timed challenges, etc). Ensure that the competition remains friendly and inclusive by balancing team-based and individual activities. You can also use digital tools such as Kahoot! or Quizizz for quick interactive games. Provide rewards that reinforce intrinsic motivation, such as verbal praise, showcasing top performers, or simple certificates. Make sure all students feel included by designing activities with varied skill levels.

- Student Engagement: At first the engagement did not increase for many students, as they were not sold on the idea. As the games continued more and more students were excited to play and participate.
- Student Confidence: Students stated that gamification made them feel comfortable practicing math concepts as they were more focused on the competitive aspect, rather than the fact that they were doing math.
- Motivation: Students expressed that they felt more motivated to complete tasks and participate when lessons were structured as challenges or games, as they wanted to win.

#### Personal Reflections and Rating:

Gamification boosted the energy in the classroom, and increased involvement from some students. It fostered a positive environment where students felt encouraged to participate and learn. However, it takes a lot of work to ensure that the game aligns with the actual educational content. It can also be disappointing to do extra work to prepare a game when students decide they are uninterested.

Rating: 3/5



# Strategy 8: Mistake-Centered Learning

#### What the strategy is:

Mistake-centered learning focuses on creating a classroom environment where mistakes are seen as valuable learning opportunities. Rather than penalizing errors, this strategy encourages students to analyze and learn from their mistakes, promoting a growth mindset and helping them build resilience in problem-solving.

#### How we implemented the strategy:

We implemented mistake-centered learning by encouraging students to reflect on their mistakes during problem-solving activities. Instead of immediately providing answers, we structured discussions around errors, asking students to explain why a mistake might have occurred and how it could be corrected. We used the vocabulary "agree or argue" so that students could work together as a class to justify if/why an answer was correct. We used group work so that students could help identify each other's mistakes and work together to find solutions. Additionally, we regularly incorporated activities where students had to correct their own mistakes and reattempt problems, fostering a mindset that errors are part of the learning process.

# How we would suggest others implement it in the future:

Start by normalizing mistakes in your classroom environment, letting students know that errors are a natural and essential part of learning, even if this requires you to make purposeful mistakes that students might make. Provide opportunities for students to make and analyze mistakes during class activities, allowing them to explain their thought process and reflect on the solutions. Use questioning techniques that prompt students to recognize and correct errors themselves, rather than immediately providing the correct answer. Do not answer questions that allow students to stop thinking. For example, if a student asks if their work is right, do not say "yes" or "no", try saying "you tell me" or "how could you check?". In addition to this, make sure to emphasize effort and improvement over perfection.

- Student Engagement: Many students said they were more willing to take risks in their learning, allowing them to engage more in problem-solving.
- Student Confidence: The confidence of students increased, knowing that mistakes were not something to be ashamed of, but instead accepted and used as growth opportunities.
- Motivation: Students felt more motivated to keep trying after making mistakes, as they knew the focus was on improvement rather than immediate success.

#### Personal Reflections and Rating:

Mistake-centered learning helped shift the classroom dynamic towards a more positive, supportive, and resilient learning environment. It encouraged students to approach challenging tasks with a growth mindset, knowing that making mistakes was a necessary step toward mastering the concepts. However, we do feel that the best thing a teacher can do to make sure students are comfortable making mistakes, is not through instructional strategies, but instead through building relationships with students.

Rating: 3.5/5



# Results of our Project

# Overall Impact:

The implementation of these strategies led to a noticeable improvement in student engagement, confidence, and motivation. Students became more actively involved in their learning, and the classroom environment became more supportive. These strategies created an atmosphere where students were more comfortable taking risks, and learning from their mistakes. Techniques such as vertical whiteboards and group work were especially effective in promoting community and collaboration.

#### Reflections:

A key takeaway from this project was the importance of building a safe space for mistakes and encouraging critical thinking. When students felt that errors were part of the learning process, they were more confident in experimenting with new ideas. Going forward, we both feel that it will be essential to continue learning and trying new strategies that are both challenging and accessible for all of our learners.

# Final Thoughts:

We plan to continue using these strategies in future lessons, refining them based on ongoing student feedback and classroom observations. This experience confirmed that fostering strong relationships, encouraging critical thinking, and using engaging instructional methods can significantly boost student confidence and motivation.

#### Conclusion:

This project reinforces that creating a positive classroom culture and using certain instructional strategies can transform students' relationship with math. By incorporating these instructional strategies, we can encourage students to approach challenges with a growth mindset. This not only builds their confidence and capabilities in math but also fosters resilience, creativity, and a curious mindset, which are essential skills for both academic success and lifelong learning.

### Resources

#### Literature:

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McCarthy, J. (2017). Using gamification to ignite student learning. Edutopia.

Wang, C. (2021). Peer teaching as an effective method: A case study at ST University in China. *Journal of Higher Education Theory and Practice, 21(6),* 189.

Wiliam, D. (2011). Embedded formative assessment. Solution Tree Press.

Van de Walle, J. A., Karp, K. S., & Bay-Williams, J. M. (2019). *Elementary and middle school mathematics: Teaching developmentally* (10th ed.). Pearson.

#### Websites:

Algebra Word Problems <a href="https://www.mathtutordvd.com/">https://www.mathtutordvd.com/</a>

Building Thinking Classrooms <a href="https://www.buildingthinkingclassrooms.com/">https://www.buildingthinkingclassrooms.com/</a>

Esti-Mysteries <a href="https://stevewyborney.com/">https://stevewyborney.com/</a>

Flippity <a href="https://www.flippity.net/">https://www.flippity.net/</a>

Growth Mindset <a href="https://www.mindsetworks.com/">https://www.mindsetworks.com/</a>

[Math]odology <a href="https://www.mathodology.com/">https://www.mathodology.com/</a>

NRICH website <a href="https://nrich.maths.org/">https://nrich.maths.org/</a>

Number Talks <a href="https://mathforlove.com/lesson/number-talks/">https://mathforlove.com/lesson/number-talks/</a>

Which one Doesn't Belong <a href="https://wodb.ca/">https://wodb.ca/</a>