Introduction

This document is a resource for deciding which Math Maker Challenge you wish to use. We offer a starting point with example challenges for those running this project for the first time. For those looking to make their own challenge or wanting ways to level-up the challenges, we offer a DIY checklist as well as conversations around four main strategies for upping the challenge and the intrigue.

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Example Maker Challenges

Consider using these specific maker challenges for your first *Play. Create. Share.* project.

(Kinder and 1st)

Make your own math memory cards.
See if this time it'll be harder for the adults.
If you want, change the rules a little bit too.

(2nd and 3rd)

Make the coolest math twist on Achi
where the kids, on average, beat the adults.

(4th and 5th)

Make the most addictively tricky
math Cannonball or turtle puzzle experience.

DIY a Maker Challenge

In its simplest form, a good maker challenge brings out the first two steps in the Creativity Roadmap: Creative culture, productively managing mistakes. A good maker challenge has five core components.

DIY Checklist

Tantalizing, clear goal	▫ Students find the challenge fun and exciting. ▫ The goal is clear enough to gauge progress. ▫ The project is novel and non-routine. ▫ Achieving the goal is challenging and takes several iterations. ▫ (Bonus) students iterate at least 3 times.
Unclear path	▫ Student actions are not spelled out. ▫ Students are given, or find, knowledge "just in time." ▫ The project is effortful. ▫ Students demonstrate a willingness to act before without knowing what works. ▫ Students make mistakes, but learn from them and improve. ▫ The challenge cannot be completed on a students' first attempt. ▫ Students don't freeze or quit when encountering ambiguity. ▫ (Bonus) Students expect and value mistakes.
No one right answer	▫ Students feel free and open, not closed or fearful. ▫ Students are clearly given room to add their own unique contributions. ▫ Students are able to incorporate their own creative expression. ▫ Students don't want to copy the teachers or another student's work. ▫ (Bonus) The project incorporates creative expression in meaningful ways.
Evoke "go for it"	▫ By and large, students have an emotional response that drives them to act creatively. ▫ The frozen or nervous student is encouraged and eventually gets started.
Focus on others	▫ Students find the project purposeful or meaningful because their effort directly impacts other people. ▫ Students feel proud of what they made and of the effort it took to produce it, predominantly because of the impact it has on other people. ▫ Students get to see other people actively use their creation in real-time, right in front of them.

Additional Challenges to Consider

- Kinder - 1st
  - Make the most fun, but tricky math memory game that's also tough for adults.
  - Make your own math memory cards that show numbers in cool ways without using stripes and dots.

- 2nd - 3rd
  - Make the most addictively tricky multiplayer math twist on Achi.
  - Make the coolest math twist on Achi that a student 2 years younger than you enjoys playing.

- 4th - 5th
  - Make the most addictively tricky twist on Turtle Sums that doesn't use addition at all.
  - Make the easiest Turtle Sums puzzle that takes an adult at least 3 minutes to solve.
  - Make the easiest Turtle Sums puzzle that is surprisingly tricky until it's solved.
  - Make a Turtle Sums puzzle so that a 2nd grader will get stuck, but stick with it for 10min and eventually solve it.
  - Hardest puzzle a student one year older than you will stick with and solve.
  - Coolest puzzle that takes a 6th grader at least 5min to solve.
  - Make the most addictively tricky Cannonball puzzles, but this time use real foam balls so that the puzzles are in 3D.
  - Find a super cool, ancient game from somewhere around the world. Make your own math twist on this game that is the most replayable.

Level Up Your Challenges

Game-Usage Goals

Any of these prompts could also be turned in to a fundraiser for the school - much like a jog-a-thon but with games. Students could set prices each time someone plays the game or they could leave the price opened like a donation. You could additionally add quantifiers to the challenges, for example:

- Look for the most total minutes of gameplay.
    - This could happen with a game that people play for a long time or a game with huge multiplayer capacity.
        - 30 ppl playing for 15 minutes gives us 30x15 = 450 minutes.
    - Replayability is also a big factor
- Look for the most fundraising from the game.
    - This could happen from a flat fee each time to play or replay the game. The more people that want to play or the more replays you can achieve the more money to make.
    - This could happen from a pay as you go structure. For example, rather than a flat fee to play the game, each move the player makes costs $0.10.
    - This could happen from having copies of the game for sale at say $10.

In all cases, be mindful of the prompt and the challenge as well as when to bring in the fundraising component. It's generally best to add this to the challenge at the very end, otherwise students will focus on money and not on testing and iterating their game. The goal here is not to introduce an external motivator but to encourage students to focus even more on people sticking with a game.

A game that is nice to look at but has no strategy will be boring and people won't want to play. To get enough time or money from the game, it needs to be engaging to play and replay.

Ill-Defined Problems

Another way to level up the challenge is to set up the challenge in such a way that a Student has a sense or a feel of what success is, but has to come to grips for themselves with what it looks like.

Spend less time showing them what success looks like and instead let them uncover what success feels like. Offer a slightly ill-defined problem in which students have a general sense of "I'll know it when I see it", but have to decide for themselves how to monitor progress towards that goal. Here are a few examples with some questions students may need to grapple with with each one.

- Coolest - what does it mean to be a cool game? How will you know if you are making the game cooler or not?
- Most Fun - tricky, but not too tricky? A quick game? A longer one?
- Most Addicting - nagging at you? Stick with it all at once? Come back to it?
- Trickiest - lots of tries? Guessing ok? Takes a long time to solve?

Change the Audience

Students are designing for others to play. It encourages testing. It can also offer a more open problem. Change the audience to be something students don't yet "understand" and need to empathize with. For example, what is considered hard for adults vs kids or what do students 1 year older than me like?

If you want, change the audience to be students NOT in the class. It offers a sense of intrigue and ambiguity, builds empathy, and solidifies the desire to test. It also builds community by breaking the silos in math education. Here are a few examples.

- 2nd graders
- Students one year older
- Students one year younger
- Adults
- Families to play together
- Teachers and Administrators
- 4th grade teachers
- Janitorial Staff

Making a Game From Scratch

Students can learn alot about testing and iterating by tweaking something that already exists. This allows students to add to or improve an existing game and takes away the need to worry about all the game mechanics. When students create a game entirely from scratch, it's easier for them to fall into the trap of random dice rolls or math facts. These generally produce uncompelling games and encourage kids to not test and iterate. The biggest driver of the need to test and iterate is strategy. When a student's game is strategy-free it will be very difficult to get them to iterate in a meaningful way.

To boost the desire and need to test, especially when running a challenge of making a math game from scratch, focus on using math as a tool for decision-making. Most specifically, math should be integrated into the game using these principles.

- Mathematical concepts and/or standards of mathematical practice are a crucial and enjoyable element of the game. They Integrate with the strategy so that the most important decisions in the game are mathematical in nature.
- Math is not a sidebar in which you pause the gameplay to calculate nor where you just calculate and if right move on. If calculations are involved, they are never done randomly.
- The player decides which calculations to do and carries them out with/for a strategic purpose.
- Math is an integral part of the most important decisions in the game.
- Math helps with the strategy of the game.

Good Use of Math in Games - Three Principles

As we move students closer and closer to making their own game from scratch, we want to begin building up the foundations for being able to design so that

1. Math (and its principles) adds a degree of **intrigue**.
2. Players **interact** with math (and its principles) without formulas, worksheets, flash cards, or calculators.
3. Math (and its principles) **inform** the strategy in the game

These are the same three principles used in all of our MathMINDs Games.