GAME UP YOUR MATH!

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Let’s Play!

Lines & Blobs

Line up alphabetically by first name!

AbCdEfG....
Blobs
Blob (make groups)
by favorite color!
That was fun! 

**BUT**  **AND**

- (Fun can be a goal, too!)

- What other goals were accomplished?

- Think about how you could modify this for your classes to use as a first-day icebreaker.

- Share ideas with your neighbor.
How do games work to promote learning?

Games use some of the best aspects of collaborative and active learning.

Students are excited, so focus more.

Students are less anxious, so are willing to take on greater challenges.
The Coin Game

Do NOT Open the envelope until you have solved the problem!

- This envelope contains pennies and nickels.
- The number of pennies **IS** 6 more than the number of nickels.
- The total amount of money in the envelope is $0.30.

If you solved the problem correctly, **KEEP** the money.

If you did not solve it correctly, **GIVE BACK** the money.

Either way, go on to the next envelope!

Bonus Round – Double your money!!!
Put some of your money in this envelope, and write a word problem for it, here:

- This envelope contains _____ and __________.
- The....
- The total amount of money in the envelope is _____.

Give the envelope to another group.
If the other group solves your the problem correctly, you get **double the money you gave them**.
Why do Games Promote Learning?

A good game influences each of these strands:

- Students have to adapt as the rules change
- Students strategize to get the best game results
- Concepts are built into the game and practiced until fluency

That’s a lot to ask for and only happens in very good games...

But even a simple game can influence productive disposition!
Games can create a world apart...

The arena, the card-table, the magic circle, the temple, the stage, the screen, the tennis court, the court of justice, etc, are all in form and function playgrounds, i.e. forbidden spots, isolated, hedged round, hallowed, within which special rules obtain. All are temporary worlds within the ordinary world, dedicated to the performance of an act apart.

Mad Math, or Math Libs

The Leader has the paper and does not show it or read it to the group until the end!

Leader: ask your group to give you a noun, and adjective, etc., up to and including the numbers at the end.

Once everything is filled in, read the story to your group, then do the problems!
How could you modify this for your own class?

- Algebra
- Statistics
- Arithmetic
- Liberal Arts Math
- Calculus
- ....
A Study of 440 students at BMCC

In all classes, the game-based classes showed higher enjoyment than the non game-based classes, with math showing the highest gains, from 61.3% enjoying the non-game lesson to 76.5% enjoying the game-based one.

In the three math classes, there was a strong positive linear correlation ($r=0.967$) between enjoyment of the lesson or game and the deep learning portion of the quiz grade. This means that, on average, the more a student enjoyed the lesson or game, the better they did on the conceptual questions on the subsequent quiz. (2016, A Proof-of-Concept Study of Game-Based Learning in Higher Education, Simulation and Gaming, F. Crocco, K. Offenholley, C. Hernandez)
Further reading

- Keith Devlin, *Mathematics Education for a New Era*
- James Gee, *What Video Games Have To Teach Us About Learning And Literacy*
- *The Allure of Play,* by Joe Bisz and Victoria Mondelli will be out this year.
Let’s Play!
Bizz Buzz for Base Systems

Count: “One, two, three, four, BIZZ”

Great for liberal arts math to teach base systems. I use it along with base 5 blocks to teach base 5, and then we play it in base 7.
The Game of Set

- [https://www.setgame.com/daily_puzzles](https://www.setgame.com/daily_puzzles)

- To make a “set” of three cards, all three cards must be the same in an aspect (number, color, fill or shape), or all three must be totally different in an aspect.

- All three cards could be the same number, the same shape, and then three different colors and three different fills.
Paper Tear-ups

Algebra Version
Instruction to students (or pairs of students): on a piece of paper, multiply two binomials like my example on the board, but your own choice of numbers.

\[(x+2)(x-5)=x^2-3x-10\]

Calculus Version
Instruction: on a piece of paper, write a function of your choice and then find its derivative.
Tear the paper in half!

Give the “answer” half to another student or pair. They have to figure out what you started with.

This explicitly links factoring to multiplication in a memorable way.

In Calculus, it vividly links the integral and derivative and explains the need for that “dumb C”
Awesome Modification

Instead of trading in pairs, tape all the “problems” up on one side of the board, all the “answers” on the other side.

Challenge teams or individuals to find the matches!
Modification for College Algebra

One side can be exponential form, the other side is the log form – maybe with one number deleted!

Challenge teams to find the matches and the value for x!
The Spread of a Rumor

- Each student starts with a card like this, but ONE student has a card marked with a YES on round zero, meaning they know the rumor!

- Each round, students get up, mill around, and show their card to one other student. They mark their card with a YES if they see a card that has a YES on it.

- If your card has a YES on it, you write YES for all the rest of the rounds.

- When you are done with round 5 or 6 (when everyone knows the rumor), ask the class how many knew the rumor in round 0, round 1, etc.

<table>
<thead>
<tr>
<th>Round</th>
<th>Do you know the rumor?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Round 0</td>
<td>NO</td>
</tr>
<tr>
<td>Round 1</td>
<td></td>
</tr>
<tr>
<td>Round 2</td>
<td></td>
</tr>
<tr>
<td>Round 3</td>
<td></td>
</tr>
<tr>
<td>Round 4</td>
<td></td>
</tr>
<tr>
<td>Round 5</td>
<td></td>
</tr>
</tbody>
</table>
The Spread of a Rumor

- The number that know the rumor roughly doubles each time, showing *exponential growth* (actually logistic growth, since it has a ceiling).
- The growth can be compared to the spread of a virus, population growth, “viral” internet news, and more.
Calculus “Art on the Wall”

- Draw a curve on a post-it note from one corner to the other.
- Person 1: concave up and decreasing
- Person 2: concave down and decreasing
- Person 3: concave up and increasing
- Person 4: concave down and increasing
- Put the shapes together, identify inflection points, discontinuities, etc.
PowerPoint Jeopardy

- Great for a test review!
- There are templates all over the web – search for “PowerPoint Jeopardy template”
- Or use my simpler test review, “the finish line”....

<table>
<thead>
<tr>
<th>Multiply &amp; divide decimals</th>
<th>Convert decimals &amp; fractions</th>
<th>Add and subtract fractions</th>
<th>Round &amp; compare decimals</th>
<th>Multiply &amp; divide fractions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q $100</td>
<td>Q $100</td>
<td>Q $100</td>
<td>Q $100</td>
<td>Q $100</td>
</tr>
<tr>
<td>Q $200</td>
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</tbody>
</table>
The Finish Line

Great for a test review! Make a line on the board like this:

Start → [with many more boxes than this] → End

Every time a group gets 4 correct on the test review, they role a die to advance along the line. This is less time intensive than creating your own PowerPoint Jeopardy, and just as fun.

You can use a real die, or do a search for “virtual dice.”
Time to game up your math!

- Think of a lesson or activity that you did in one of your math classes.
- Not a game, just a lesson or activity that you did that you really liked, that you felt was pretty successful. If it employed group work or active learning, great! If it didn’t, that’s fine, too!
- Write down a sentence or two about it on a piece of paper.
Core Game-Based Learning Principles

- **Identity.** Student might give a presentation from the perspective of a historical or fictional figure, or from the perspective of someone who uses mathematics for their job. Identity provides students with a sense of academic responsibility.

- **Co-design.** To encourage co-design, let students have agency over their work (e.g., choosing their projects or an aspect of a project).

- **Well-scaffolded problem.** The hypothesis students form earlier assist them later as the tasks get more complex.

- **Situated meanings.** New terms are compared to similar items students already know, so that new concepts can be fit in with concepts students already know.

In one sentence, write down which one of these principles your exercise contained and why.
Simple Game Mechanics

**random**
- Simple mechanic
- An exercise with a random pace allows students to recreate the meaning themselves.
  - Rolling dice
  - Shuffling and drawing cards
  - Solving a problem in a non-linear way (puzzle, analogy)

**rapid**
- Simple mechanic
- An exercise with a rapid pace simplifies the details for the student.
  - Task time limits
  - Most correct answers within a given time
  - Breaking your presentation into short, quick chunks

**rival**
- Simple mechanic
- Rivals give students a goal to compete against.
  - Another student or team of students
  - A challenging teacher
  - A challenging game
  - Cooperating with a team against a rival

**reward**
- Simple mechanic
- Rewards give students a goal to feel accomplishment from.
  - Candy & Stickers
  - Extra-credit
  - Reward charts
  - XP
  - Points
  - Badges
  - Quests
  - Instant feedback (game, teacher, peers)
  - Work that feels personally meaningful

**role**
- Simple mechanic
- Roles give students a goal to identify with.
  - Moods (honor, empathy)
  - Themes (exploration, science)
  - Narrative and fantasy
  - Thematic character (real-life or fictional)
  - Position on a team (with a specialized role)

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**random**
- A lecture or assignment with random elements creates a pleasing pace of surprises. In addition, since students may become bored by the linear, top-down nature of classwork, accessing your content randomly lets them piece together the meaning themselves.

**Exercises:**
- Break a workbook chapter into sets of 6 questions. For every set, students only answer the question corresponding to the number they roll on a die.
- Carve up your lecture onto a series of randomly distributed flashcards. Students must figure out the conceptual relationships between these chunks of information.

**rapid**
- Presenting students a series of rapid exercises with small discrete tasks can prevent an assignment from becoming an endless slog. Also, a rapid lecture requires an overview, which encourages you to provide only information that’s really important (the rest is as needed).

**Exercises:**
- Rush through your presentation, then redo it more slowly, amplifying what’s confusing. The second presentation will have direction and context for students.
- Make move time not passive. During a video about Ancient Rome, say “Can you identify the structures from our reading being shown here? Take just 1 minute to write as the movie plays, and we’ll see who get the most correct–go!”

**rival**
- One of the ways to know if you are doing well is to compare yourself to others. Rivals serve as a yardstick for personal progress, due to the unique way they meet a similar task.

**Exercises:**
- Ask each student 3 increasingly difficult questions, worth 1 point each on a public scoreboard, but an incorrect answer ends the student’s turn. Limit questions to 5 so smart students will not carry the scores too far apart.
- Teams work on the same exercise, and during their debrief with other teams, at least one quantifiable outcome is compared highest score, highest number of citations/results found, class vote for best team idea, etc. Teams allow for cooperation during rivalry.

**reward**
- Feedback is addictive, especially from a well-designed game that responds to your every action, or from a teacher who knows exactly what to say. But rewards like candy and stickers also carry a valuable kind of emotional feedback.

**Exercises:**
- Students work while you walk around room giving quick feedback (5 to 10 seconds tops each). Or they work on computers while you respond quickly on your computer.
- Students score points, which only help their grade, for completing workbook pages, with extra points for certain achievements. A point system motivates if immediate, specific, and not high-stakes.

**role**
- Roles help define perspective, so the student can more readily find a path through an abstract problem. They will also feel responsible to a team that relies on them for their particular knowledge.

**Exercises:**
- A single student or team argues aloud a position from two conflicting roles (e.g. civil disobedience from Malcolm X and Martin Luther King). This encourages logic and personal detachment.
- Add role qualifiers to questions, e.g. “What is one solution to climate change [if you are a stay-at-home parent]?”
- On team projects, one student takes charge of editing the grammar, another the argument, and another the citations.
Now go back to that lesson or activity...

- In one sentence, write down one or two of the simple game mechanics your lesson contained (if any).

*Random, rapid, rival, reward or role*....

- Now pick one or two simple game mechanics that did *not* exist in your lesson.

- In a few sentences, describe how you might add these mechanics to your lesson to make it even better!

- Share your new lesson with your neighbor. What was it to begin with, and how did you change it?
Time to game up your **difficult** math!

- What’s a topic you find tough to teach?
- Let’s work in groups with some *complex mechanics* to create a game or game-like activity to teach that topic!
- If you don’t have a topic, your group can flip over a lesson card or two to help you decide!
Complex Mechanics Cards

- Each group gets two complex mechanics cards.
- Flip over both cards, then decide as a group which one card you will use to create an activity together.
- Focus on the simple mechanics that combine to make the complex one.

Random, rapid, rival, reward or role....
Share your Activities!

- What cards did you start with, what did you choose?
- Describe what you came up with.

COMPLEX MECHANICS: 9 GAMED-UP TEACHING APPROACHES
FOR CREATING RIGOROUS LEARNING GAMES
BY PROF. JOE BISZ
Creating a Whole Game

- We created game-like activities
- To create a whole game, it easiest to use an existing game that you like (Mad Libs, Jeopardy, Monopoly, etc.)
- You can play What’s Your Game Plan? to help you create a whole game.
- Whatever you make, keep in mind that it will probably take several iterations of it before you are really happy with it.
Evaluation

- https://www.surveymonkey.com/r/TWBCC19
Our Digital Games

- Created by expert game designers
- Created with explicit learning objectives
- Made possible by an NSF Grant
- Used in sections of our remedial algebra class for STEM majors
Let’s play xPonum!

- Created by Neuronic Games
- **xPonum** is a puzzle game in which players collect gems using a beam of energy.
- Game play emphasizes exploration, so that players experience mathematics as being about trying out various ideas, not just about already having the answer.
Let’s play xPonum!

Ipad password: abcdef

Click on xPonum

Click on 001.

Fire the beam!

The first levels involve only a little math, and are teaching you how to play.

But notice: you are manipulating the equation of a line!

This is the equation $y = 1x$. 
xPonum

- At the basic level, in the first world, players use slope and intercepts and must find points along the line, using the slider to shift the line. This level can be played in an introductory algebra class.

- At later levels, players explore shifts in parabolas, cubic and trigonometric functions, which are suitable as pre-calculus topics.

- Available for free download and in the app store.
Let’s play Algebots!

- Created by Bumblebear
- **Algebots** is an equation-solving puzzle game, with little robots who cheer when you get the steps right, and fall asleep if you don’t move them around.
- Equations range from basic to advanced, including absolute value, systems and radical equations.
- The game emphasizes that solving is about “undoing” – applying the inverse function – to both sides of the equality or inequality.
Let’s Play!

- Project Sampson, created by Electric Funstuff
What Games will you play with your classes?

- You can imitate one of these games
- Or create your own unique game using a game you know, like Clue, Apples to Apples, Checkers, or Blackjack
- You can also use “What’s Your Game Plan?” a card game created by Joe Bisz that helps you invent your own game.
Questions? Like to learn more?

Dr. Kathleen Offenholley, Kathleenoffenholley@yahoo.com

- Links to downloads and instructions for the digital games: https://mathgamesforstem.wordpress.com/
- Kathleen’s blog on Game-Based Learning in Undergraduate Mathematics: https://mathgames.commons.gc.cuny.edu/
CUNY Games Conference 5.0

January 18, 2019
Borough of Manhattan Community College (BMCC)
New York City

Talks, posters, arcade demos, playtesting, workshops and more!

Save the Date!

For more information: www.cunygames.org