

MATH GAME CATALOG

BACKGROUND

Based on historical learning trends on the impact of out-of-school time on learning, we know that students suffer the most learning loss in math. Three studies based on NWEA data predicted students could learn half or up to a full year less math in 2020-21 due to the COVID19 pandemic, compared to what they would learn in a typical year.¹

All estimates from the COVID19 pandemic suggest that this learning slide will be compounded in cases of inequity and much more devastating for the more underserved communities. Data from developed countries suggest that the learning loss for the more underserved communities is more than double that of other more affluent students.² While all students are suffering, those who came into the pandemic with the fewest academic opportunities are on track to exit with the greatest learning loss.

Even prior to the COVID19 pandemic's devastating setback in worldwide education, the demand for distance learning, enrichment and catch-up learning resources has been well founded particularly in crisis-affected areas and to children of all deprived socio-economic backgrounds. Innovation Development Directorate (IDD) set out to tackle some of the most glaring issues facing students including learning away from traditional learning environments, enhanced learning and remedial learning when it set up the Internet Free Education Resource Bank (IFERB).

Adapted by educators for implementations by the parents or community volunteers, IFERB is available in multiple languages. Designed to be student lead, low resource, interdisciplinary and most importantly internet free, this bank provides projects for students across multiple levels from ages 4 to 14 years.

MATH GAMES

IDD intends to create a holistic toolkit with multiple resources to support continued education during disruption and enable enrichment in schools. One of the areas that we want to invest additional focus on is that of Math learning - 56% of children and adolescents around the world have not achieved basic proficiency in math.³ Much of the additional loss of math skills can be attributed to three major reasons:

1. Lack of resources for math learning: In marginalized communities the lack of access of math materials and manipulatives as well digitally enabled apps, games or virtual instruction created large gaps in learning.

¹<https://www.nwea.org/research/publication/nwea-data-predicts-students-could-be-up-to-a-year-behind-in-math-in-the-fall/>

²<https://www.mckinsey.com/industries/public-and-social-sector/our-insights/covid-19-and-learning-loss-disparities-grow-and-students-need-help>

³<https://en.unesco.org/news/617-million-children-and-adolescents-not-getting-minimum-reading-and-math>

2. Preparedness of parents to support math learning: Math is usually formally learned only in school leaving parents and communities much worse equipped to support math learning. Due to this perception of math as a complicated subject that can only be taught by trained teachers, it is causing further disturbances to learning during times when parent support is crucial.
3. Negative bias towards math: OECD data suggests that 1 in every 3 students globally suffer from math anxiety. Greater anxiety is consistently associated with lower scores.⁴ This anxiety is being worsened due to the additional pressure and stress caused by the pandemic.

The core design challenges that IDD worked with include:

- Minimal access to learning resources and math manipulatives,
- Limited access to teachers,
- Lack of basic core numeracy skills,
- Cultivation of a negative bias towards math and
- A lack of internet connectivity and devices to access technology based products or virtual schooling

To solve the above challenges, IDD developed Math Games. This hopes to be an easy tool to help build an understanding and love for math in a fun manner. The catalog consists of:

- A briefing note with the background and design choices
- A backend resource catalog which is a curated and categorized repository of existing open source math resources
- A prioritized set of these Math games that are written in detail
- A competency framework based on Khan Academy's common core learning principles. This includes details of skills learnt at each level from 0-3 across 5 different math strands.
- Monitoring - Evaluation and Learning guide and tools to accompany these Math games

CORE FEATURES OF MATH GAME CATALOG:

- All suggested games require very basic or no resources (where applicable, alternatives will be suggested).
- All suggested games require no technology or internet connectivity to complete.
- All the offerings are designed to be fun and gamified to build engagement for self-lead or community facilitated learning.
- The math game catalog will be for learners between the ages of 4 – 14 years across 4 levels: Level 0 (4 – 5 years), Level 1 (6 – 7 years), Level 2 (8 – 10 years), Level 3 (11 – 14 years).
- The selected games will be mapped to all the core curricular skills as defined in 5 international curricula including: American, Australian, Qatari, British & Indian.
- The skills and competencies are prioritized with the same representation as in the curriculum i.e. Numbers & Algebra 60%, Geometry & Measurements 30%, Data handling & Probability 10%.

⁴<https://www.oecd-ilibrary.org/docserver/5js6b2579tnx-en.pdf?expires=1616047163&id=id&accname=guest&checksum=B54C092B802A4933761E7B654FFD229B#:~:text=PisA%202012%20measured%20students'%20anxiety,attempting%20to%20solve%20mathematics%20problems.>

- The games are a mix between open source available online resources and those created by the working team for this outcome.

DETAILS ON EACH OF THE OUTCOMES:

- The backend catalog of math resources:
 - Is a matrix of open source math activities and games tagged against the 4 levels of math learning from 4 – 14 years against all the core skills as identified in chosen international curriculum
 - Is a matrix that includes fields for math game name, source, math strands, skills, and associated resources
 - Contains multiple games that have been selected for each skill to practice and anchor learning i.e. 50+ games for each of the 4 levels
 - Are either open source that are available on websites or internally developed
 - Is a list that has been reviewed internally by EAA and externally by the M-Power experts
- The detailed prioritized math games:
 - Are 25 games per level that are written up adapting some of the open source activities and converting them into games that are easy to follow and use as well as writing some bespoke games

CRITERIA TO SELECT GAMES FOR THE BACKEND CATALOG

1. Based on the skills of the 5 international curricula (American, Australian, Qatari, British & Indian) we are using to cover at least 70% of the main three strands of math (Numbers & algebra 60%, Geometry & measurements 30%, Data handling & probability 10%) in the prioritization reflected in the curriculum that students need to learn and practice for each level or age. Multiple games have been selected for each skill to practice and anchor learning.
2. All games require no internet, connectivity or devices.
3. All the games require very basic resources found in basic homes (basic, scrap and junk materials) with multiple alternatives and the ability for students to make their own resources if they are unavailable (instructions on making your own dice, playing cards etc. are provided)
4. Cost free and open source content (with some attribution requirements)
5. Combination of games that can be played individually and in groups
6. Games that meet all students' learning styles
7. Fun games that include an aspect of competition
8. Games that are easy to play with simple instructions to grasp concepts through applications
9. Games that are easy to differentiate to different levels of abilities

CRITERIA ON SELECTING OR DEVELOPING GAMES FOR THE DETAILED WRITE UP

1. Represent all the important core skills of math fluency that need to be built on
2. Include different types of games for different types and preferences of skills
3. Are all low resource
4. Are all easy to play
5. Are fun to play
6. Playing the game will introduce / reinforce the intended skills

WRITE UP OF DETAILED GAMES

- Template is under Appendix 1

PROCESS OF RE-WRITING THE DETAILED GAMES

- The selected games are divided between partners and written up with detailed steps and instructions
- These instructions need to be very clear and detailed keeping in mind that students might need to work on these resources themselves
- All of the activities need to be adapted to a game in order to retain the features of fun and competitiveness knowing that students might have to be self-motivated
- Alternatives for resources and detailed instructions on how to make resources
- All the games are reviewed internally and externally before finalization

EAA was supported in developing these tools by the mEducation Alliance and Julia Robinson Math Festival that have expertise and aligned interest through the Math Power work!

APPENDIX 1: MATH GAME TEMPLATE

Format of Detailed Games: It is important that all of these are written up as games with detailed steps and instructions keeping in mind that this might be used by children directly

- Name of the Game
- Age Group / Level:
- Resources Required: *High/Medium/Low*
 - *Low - Items that can easily be found within a home: pens, paper, pencils*
 - *Medium - items that should easily accessible (sand from a garden, etc)*
 - *High resources: specific materials are required to complete the game.*
- Alternate Options for the Resources:
- Strand Covered:
- Targeted Skills:
- Inspired by:
- Time Required:
 - Time to set up
 - Time to play
- Previous Learning Required:
- Support Required:
 - *High Support: Games that require an explanation of a difficult mathematical concept and involvement of adults to set up and play*
 - *Medium Support: Games that require an explanation of a mathematical concept that is usually used in everyday life (e.g. addition, subtraction etc.) and need some supervision from an adult to set up and play*
 - *Low Support: Games that require minimal support from an adult to set up and play*

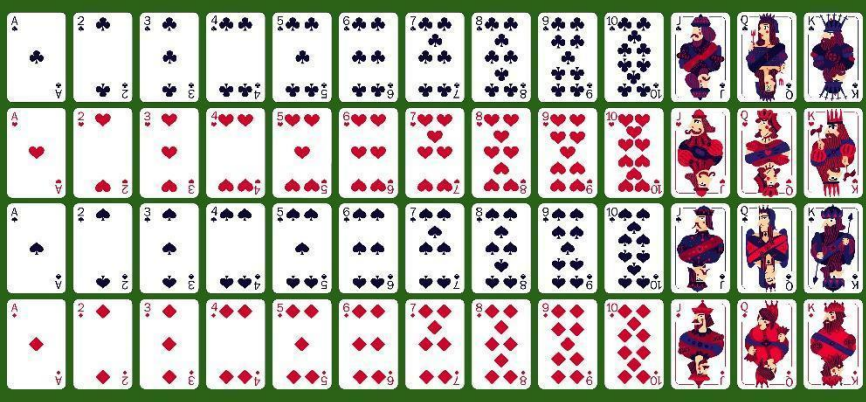
- Name of the Game:
- Objective:
- Rules:
- Steps:
- Images or Illustrations:
- Variations of the Game:
- Enrichment:
- Simplification:

THE BIGGEST NUMBER

Level	1 (Age group 6 – 7)
Resources Required	Place value grid (drawn on a piece of paper), deck of playing cards.
Alternate Options for the Resources	An adult (teacher, facilitator or parent) creates a deck of cards, 1. Draw rectangular cards approximately the size of your palm with a ruler. 2. Cut 52 of these cards. 3. Use the image in the images section and copy the same numbers, images and A's. There should be 4 cards of each number, image, and A's
Strand Covered	Numbers and Operations
Targeted Skills	Practicing Place value - comparing numbers
Inspired By	Third Space Learning – Emma Johnson
Time to prepare	20-30 minutes
Time to play	15-20minutes
Previous Learning Required	-Counting numbers between 1-99 -Recognize the place value of two digits numbers (ones &tens). -knowledge of comparing two digits numbers.
Support Required	Medium supervision

Rules of the Game

Goal	Have the biggest number out of all the players.
Rules	-Every player must only pull one card at a time and record their number on their sheet of paper. - Use the deck of cards 2-9, A's and picture cards. The cards 2-9 are each worth their digit value, Aces are worth 1 point and picture cards are worth 0 points.
Steps	Step 1: Every player should first draw a place value grid with the help of an adult, with an agreed number of places, for example: ones &tens. Step 2: Take two turns to draw a card from the pile and each player chooses what column to record the number in. For example if the player pulls up a 6 card, they can choose to write this number in the tens or ones column. So if the

	<p>learner put the number 6 in the tens and then next turn if the player pulls 3 and put it in the ones so the number will be 63.</p> <p>Step 3: Continue this until each player has played 5 times (form a number of two digits on each time) .</p> <p>Step 5: The winner is the person to have the biggest number recorded at the end of the game.</p>				
<p>Images or Illustrations</p>	<p>Place Value Grid Example</p> <table border="1" data-bbox="456 548 927 695"> <thead> <tr> <th>Tens</th> <th>Ones</th> </tr> </thead> <tbody> <tr> <td style="height: 50px;"></td> <td style="height: 50px;"></td> </tr> </tbody> </table> <p>Cards</p> 	Tens	Ones		
Tens	Ones				
<p>Variations of the Game</p>	<p>Play the game with three digits numbers. The player who has the lowest possible number is the winner.</p>				
<p>Enrichment</p>	<p>None</p>				
<p>Simplification</p>	<p>Player can change the two numbers places.</p>				

APPENDIX 2: GLOSSARY

- **Math Fluency Practice** - these activities don't involve multiple players, game rules, or a game objective. They're great for providing students an opportunity to practice mathematical topics, but they do not provide students the opportunity to strategize or make decisions using these mathematical topics. Many of these types of activities focus on helping students memorize important math facts or practice vital math procedures.
- **Math Fluency Games** - these activities do involve multiple players, game rules, and a game objective. These activities allow students to use the math that they have been learning to accomplish some larger objective. Often, the goal of these games is to do something quickly, but the best Math Fluency Games allow students to think about their decisions and leverage their mathematical understandings to do something effectively and efficiently. Math Fluency Games involve standard math facts or procedures that tie directly into most curriculums and allow students to learn the topics that they would have been learning anyway in a more engaging, memorable way.
- **Problem-Solving Games** - These activities involve multiple players, game rules, and game objectives. These games aim to provide students the opportunity to practice problem solving skills and exercise critical thinking as much as possible. Mathematical content knowledge is often a barrier that disallows many students from engaging in fun, meaningful mathematical activities, and by limiting the amount of background knowledge necessary to be successful with these types of games, these games become accessible to more students. Consequently, many of these games do not always have an overt connection to curriculum topics, but the best of these types of games involve rich and deep mathematical underpinnings that can be associated with many common standards.