

# The All-New Mathematics of Game Shows

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# *PRIZES!*

Want to win?

We'll need some volunteers for **games**.

You may leave here with *fabulous prizes!*

(Your opinion may differ from mine as to the meaning of “fabulous”.)

# *PRIZES!*

Speaking of which...

Who wants to play?

*You're our first contestant!*

# Roll And Win!

Here's a die to roll.

Every **dot** is worth a **quarter**: 10 is worth... about \$2.50.

*If you roll exactly 12 you win \$12 instead!*

But, if you roll 13 or more, you **bust** and win **nothing**.

*Good luck! Audience, help her out!*

# Analysis: Roll And Win

When is it worth stopping?

Score	\$ (stay)	\$ (go)
12	\$12.00	\$0.00
11	\$2.75	?
10	\$2.50	?
9	\$2.25	?
8	\$2.00	?

# Analysis: Roll And Win

When is it worth stopping?

Score	\$ (stay)	\$ (go)
12	\$12.00	\$0.00
11	\$2.75	\$2.00
10	\$2.50	?
9	\$2.25	?
8	\$2.00	?

# Analysis: Roll And Win

When is it worth stopping?

Score	\$ (stay)	\$ (go)
12	\$12.00	\$0.00
11	\$2.75	\$2.00
10	\$2.50	\$2.46
9	\$2.25	?
8	\$2.00	?

# Analysis: Roll And Win

When is it worth stopping?

Score	\$ (stay)	\$ (go)
12	\$12.00	\$0.00
11	\$2.75	\$2.00
10	\$2.50	\$2.46
9	\$2.25	\$2.46+
8	\$2.00	\$2.46+



# Math in Game Shows

Game shows are filled with math problems...

- Contestants

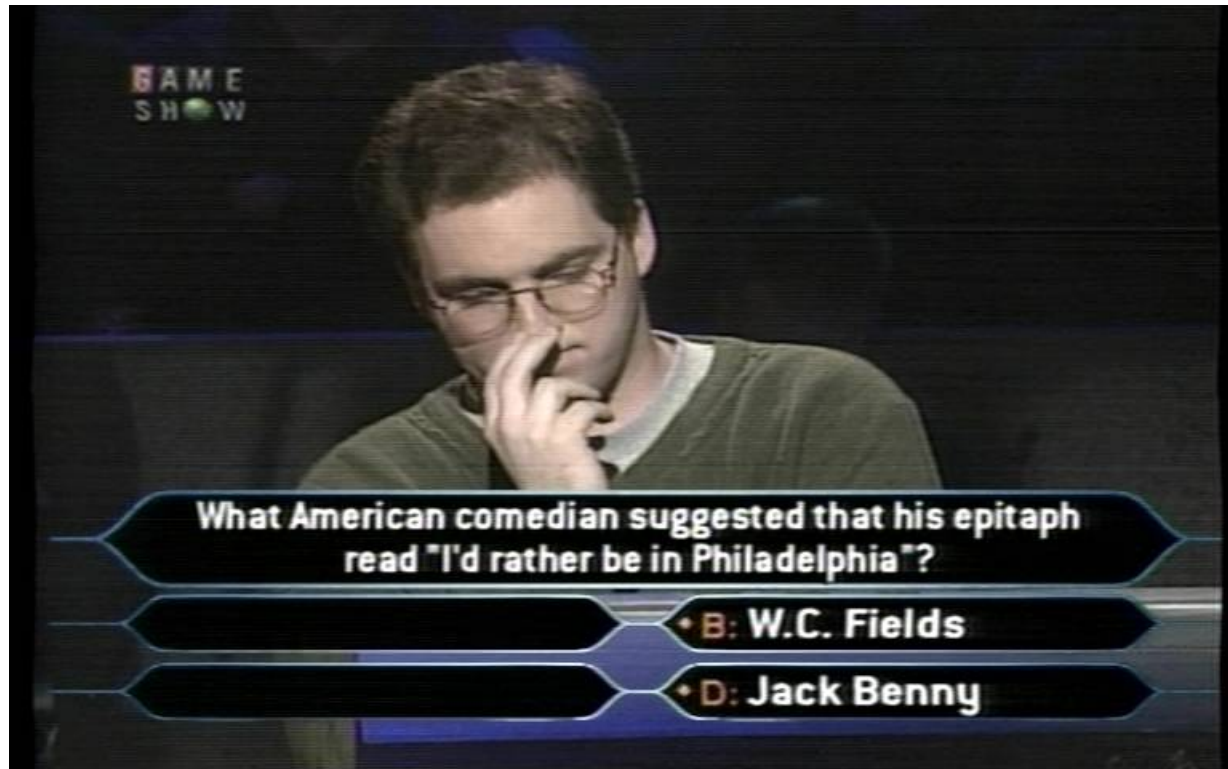
- How do I play best?
- How much risk should I take?

- Producers

- How do I build a fun game to watch?
- How will contestants behave?
- How much money are we giving out?

# Personal Encounters

February 2000: *Millionaire* (episode #49)



(for \$1000: How many degrees in a right angle?)

# Personal Encounters

February 2000: *Millionaire* (episode #49)



(Got the next one wrong. 30 million people saw my nostrils.)

# Personal Encounters

April 2004: *The Price Is Right*



(Double overbid on the showcase! Bummer.)

# Personal Encounters

May 2007: *National Bingo Night*



(We worked on this show a lot longer than it lasted.)

# Personal Encounters

August 2012: *Oh Sit!*



(Wipeout + musical chairs + Jamie Kennedy = ???)

# Personal Encounters

June (?) 2016: *The Wall* (NBC)



(Legally, this is all I'm allowed to show you.)

# Let's Play!

We're picking **one contestant** for this game.

Will you roll dice better than our last contestant? We'll find out...

**Who wants to play?**



## *Sponsored by... CME Project*

- NSF-funded curriculum from EDC / Pearson
- ~ 100,000 students nationally
- Common Core State Standards: **100% alignment**

*Now available in new integrated flavor!*

*The widespread utility and effectiveness of mathematics come not just from mastering specific skills, topics, and techniques, but more importantly, from developing the ways of thinking—the **habits of mind**—used to create the results.*

# CME Project Overview

By focusing on *habits of mind*...

- Coherent curriculum, fewer chapters
- CME was **95% aligned** to CCSSM content standards *at the time the standards were first published*
- Especially strong alignment with MPs
- **CCSSM used CME Project's language in writing MPs!**

[cmeproject.edc.org](http://cmeproject.edc.org)

(we also do house calls... but now, back to the show)

# *The Price Is Right*

- Now in its 44th year
- Lots of good math problems!
- Huge sample size of repeated play

[tpirstats.com](http://tpirstats.com)



# Dice Game

There are **four digits** in the price.

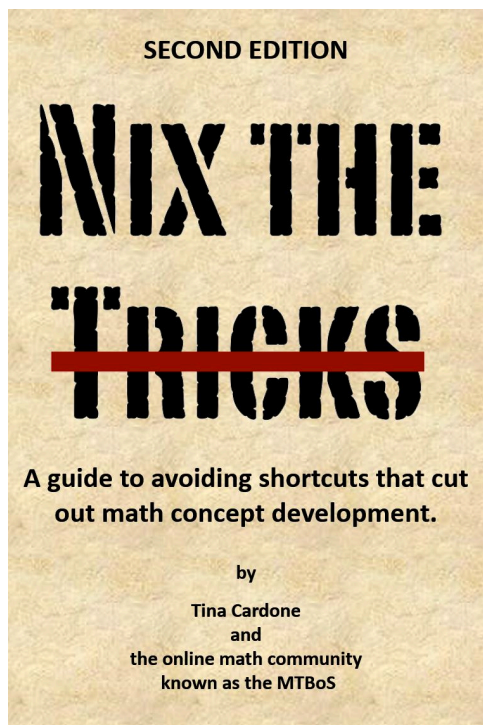
Every digit is from 1 to 6, only.

You will roll a die. If it's incorrect, you'll have to tell me if the real digit is **higher** or **lower** than the roll.



# Prize Sponsored by #MTBoS

The Math Twitter Blog-o-Sphere is an awesome place to hang out virtually and talk math.



Stop by!  
Row 1300

*Nix the Tricks* by Tina Cardone is awesome! And you can win it, right now!

# Dice Game

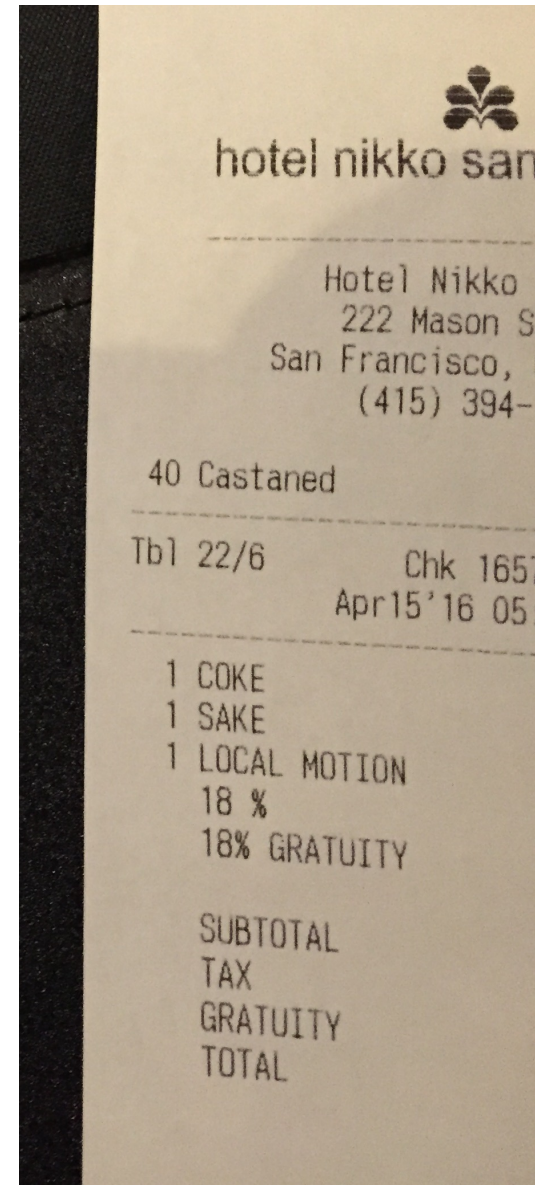
Last night at a fancy restaurant I bought:

- a soda
- 2 pieces of **salmon sushi**, and
- an 8-piece **sushi roll** called “Local Motion”.

The final price included digits only from 1 to 6.

Let's roll!

(Sushi roll, that is.)



3

6

.

3

1



hotel nikko san

Hotel Nikko  
222 Mason S  
San Francisco,  
(415) 394-

40 Castaned

Tbl 22/6

Chk 1657

Apr15'16 05.

1 COKE  
1 SAKE  
1 LOCAL MOTION  
18 %  
18% GRATUITY

SUBTOTAL  
TAX  
GRATUITY  
TOTAL

# An Unlikely Event





# The Producers' Questions

If we keep offering this game repeatedly,  
*how much will we have to pay for it?*

*How likely is a win?*

(and the most important question...)

# The Producers' Questions

If we keep offering this game repeatedly,  
*how much will we have to pay for it?*

*How likely is a win?*

*Is this game fun to watch??*

# Analysis: Dice Game

The probability of winning is heavily influenced by the **correct number** in the price.

Digit	P(correct)
1	
2	
3	
4	
5	
6	

*Take a moment  
and try to fill in  
the table.*

# Analysis: Dice Game

The probability of winning is heavily influenced by the **correct number** in the price.

Digit	P(correct)
1	4/6
2	5/6
3	6/6
4	6/6
5	5/6
6	4/6

*What can we do with this?*

# Analysis: Dice Game

For any prize, we can compute the probability of winning by using this chart.

Digit	P(correct)
1	4/6
2	5/6
3	6/6
4	6/6
5	5/6
6	4/6

*What's  $P(36.13)$ ?*

*What's  $P(3455)$ ?*

# Analysis: Dice Game

This is an especially good TPIR game because **the show can control its win rate.**

Digit	P(correct)
1	4/6
2	5/6
3	6/6
4	6/6
5	5/6
6	4/6

*This car costs \$26,165. What do you think happened?*



# Historical Data

Dice Game has been played **309** times since 2000, fully detailed on [tpirstats.com](http://tpirstats.com).

## 2000-2016

Win: **48.6%** (**150** times)

Lose: **51.4%** (**159** times)

3 out of 4 right: **73.6%** of losses (**117** times)

0 out of 4 right: **0.0%** (**0** times)

# An Unintended Consequence

The restrictions on prizes for Dice Game bleed into other games.





*Sponsored by... Marshmallow Fluff*

Marshmallow Fluff:

*The second best thing to  
ever come out of Lynn,  
MA*

Try a Fluffernutter! No,  
seriously, they're awesome.



One more game?

Who wants to play?

One more game?

Who wants to play?

Who *else* wants to play?

# High Rollers

The numbers from 1 to 9 are on the board.

Answer a question, you can **play** or **pass**.

Earn **insurance** for doubles. Use anytime (or immediately).

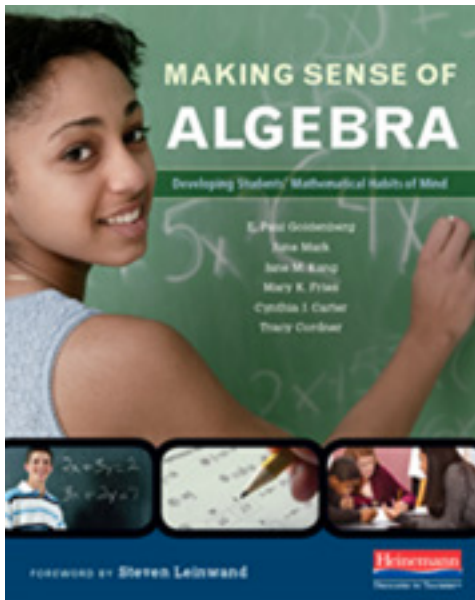
If you can't make a roll, you **lose**.



(Yes, that's Alex Trebek.)

# Prizes Sponsored by Heinemann

*Transition To Algebra* raises the competence and confidence of first-year algebra students



Stop by!

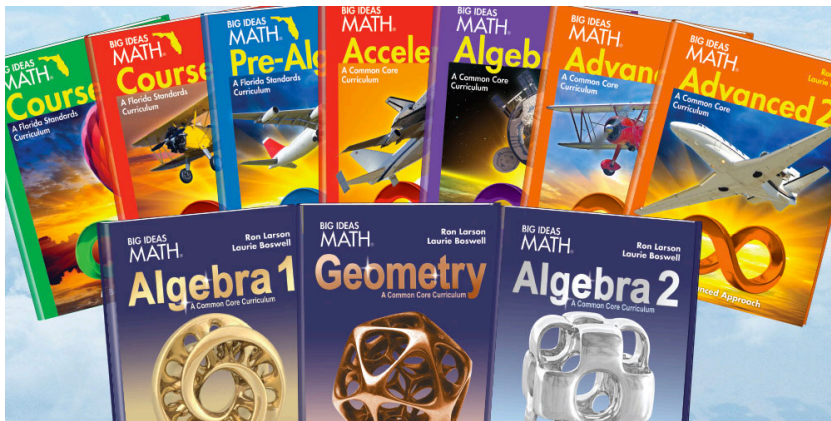


*Making Sense Of Algebra*  
also available!

# Dice by Big Ideas Math & PAPA

*Big Ideas Math* is a curriculum for middle and high school students, written by Larson and Boswell.

Stop by!



[replayfx.org](http://replayfx.org)

*PAPA* runs the World Pinball Championship and the new ReplayFX arcade festival!

4

6

# Bonus Game

In the bonus game, you play by yourself.

You win if you can knock off all the numbers from 1 to 9.

Rules from the normal game still apply.

If you can't make a roll, you **lose**.



(Numbers looked different in the 1970s.)



4

9

# Analysis: High Rollers

This is complicated! Maybe a simpler problem?

*What is the probability of winning the game if all we needed to do at the end was make a 7?*

# Analysis: High Rollers

This is complicated! Maybe a simpler problem?

*What is the probability of winning the game if all we needed to do at the end was make a 7?*

*Let's discuss some possible answers to this problem.*

# Analysis: High Rollers

Okay, let's work on this a little more.

*Pick a number from 2 to 6. Work out the probability of winning the game if that is the only number remaining, and you have no insurance.*

# Analysis: High Rollers

Wow, this is *really* complicated.

*Would you rather have a board with a 7 on it,  
or a 2 & 5?*

*Would you rather have a board with a 2 & 5,  
or a 3 & 4?*

# Analysis: High Rollers

This game has been completely analyzed.

<http://gameshowtheory.com/?p=263>

Dave (a different Dave) has determined the best play for any situation, building from simple to most complex.

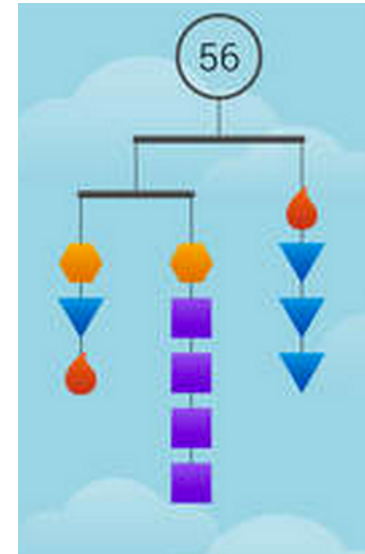
*What's the best possible first roll?*

# Sponsored by... SolveMe!

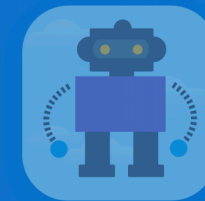
Hundreds of puzzles to  
play ... or make your  
own!

It's fun and teaches  
equation solving! Oh, and  
it's *FREE* for iPad.

[solveme.edc.org](http://solveme.edc.org)



Mobiles



Who Am I?

Coming Soon!



MysteryGrid

Coming Soon!

# Classroom Interlude

In my teaching, I found some game shows worked better than others. Games are great test review! Good as openers / wrap-ups.

## Good

### ***Press Your Luck***

Card Sharks

Millionaire

High Rollers

## Bad

Jeopardy! (*yes, bad*)

Deal or No Deal

Wheel of Fortune

Studs



# Classroom Interlude

Here are a few potential projects to try.

- Make a game with  $P(\text{win}) \approx 1/3$ .
- What are good wagers in Final Jeopardy?
- What other Price Is Right games could be played better through strategy? (Slate)
- What's the probability of winning \$1 million on Wheel of Fortune?

# Card Sharks Bonus Game

In this bonus game, you wager money on cards.

Bet multiples of \$50, up to all your money.

Add \$200 at the start of the first two rows.

*What's the maximum possible winnings in this game?*

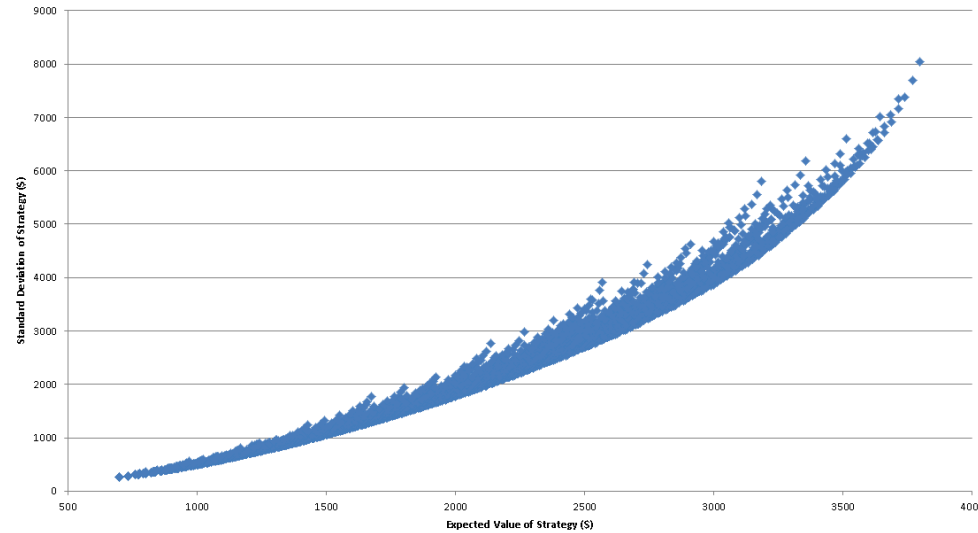


(Cards, and cars, were bigger in the 1970s.)

# Card Sharks Bonus Game

Card Sharks  
wagering analysis  
involves similar  
tactics to that of  
economic risk  
theory.

For pure expected  
value, you should  
always risk it all, but  
almost no one ever  
does.



EV on horizontal  
SD on vertical  
Greater EV comes  
from greater risk

# More to Explore

Many related topics are asked about in *CME Project*, and in the *Park City Math Institute* materials at

[www.mathforum.org/pcmi/hstp/sum2013/morning](http://www.mathforum.org/pcmi/hstp/sum2013/morning)

- How can spinners or dice be represented by polynomials?
- What makes cards different from dice, and what impact might that have on gameplay?
- What's the best possible total in an episode of Jeopardy?

Thanks and good luck!

Any questions?

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*[mpi.edc.org](http://mpi.edc.org)*

*[cmeproject.edc.org](http://cmeproject.edc.org)*