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Mathematical Zendo: A game of patterns and logic

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Cover Page Footnote

The authors would like to thank Looney Labs for their permission to explore and write about Mathematical Zendo. We would also like to thank the hundreds of students and teachers whose enthusiastic playtesting allowed us to refine the game to its current form.

Mathematical Zendo: A game of patterns and logic

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Mathematical Zendo is a logic game that actively engages participants in pattern recognition, problem solving, and critical thinking while providing a fun opportunity to explore all manner of mathematical objects. Based upon the popular game of Zendo, created by Looney Labs, Mathematical Zendo centers on a secret rule, chosen by the leader, that must be guessed by teams of players. In each round of the game, teams provide examples of the mathematical object of interest (e.g. functions, numbers, sets) and receive information about whether their guesses do or do not satisfy the secret rule. In this paper, we introduce Mathematical Zendo, provide examples of games and rules that have proven to be engaging over testing with hundreds of students and teachers, and discuss best practices for implementation.

Keywords: Logic Game, Math Game, Pattern Recognition

1 Introduction: The Game of Zendo

Zendo is a logic game designed by Looney Labs that centers around a secret rule chosen by the leader of the game. The goal of the players is to be the first to correctly guess the rule. In the classical version of the game, players or teams of players build structures that may or may not satisfy the hidden rule. Structures are built out of pieces called pyramids, wedges, or blocks, and come in the colors blue, red, or yellow. Structures can contain any number of pieces which can interact in a variety of ways. For example, the pieces may

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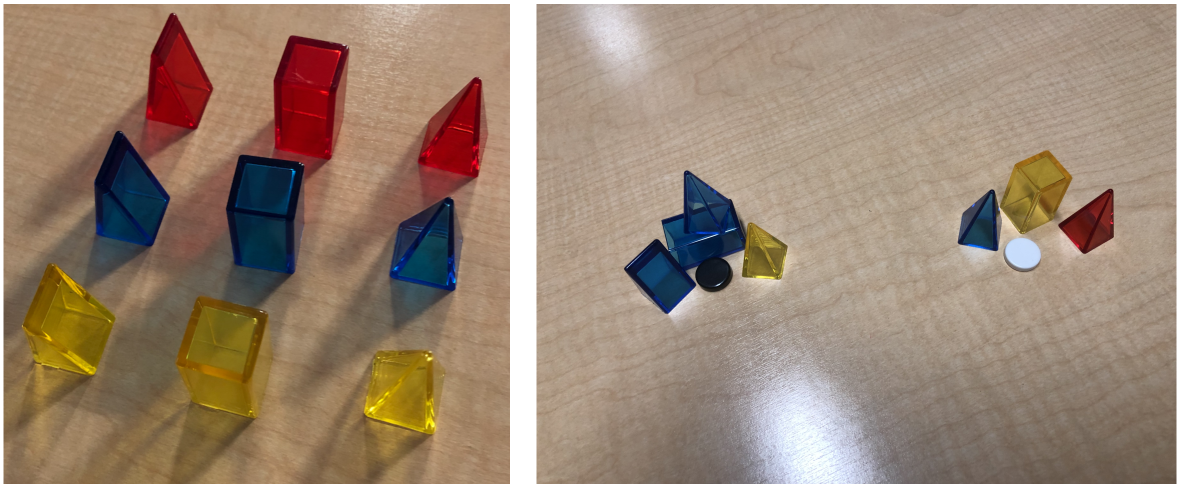


(a) Zendo pieces *(b)* Marked structures
Figure 1. The components of Zendo

be stacked, oriented sideways, or can even point in particular directions. Each structure is marked according to whether or not it satisfies the hidden rule; structures satisfying the hidden rule are marked with a white stone, and those not satisfying the rule are marked with a black stone. See Figure 1 for pictures of the different components of Zendo.

When a game of Zendo begins the leader of the game creates two structures; one that satisfies the hidden rule, and one that does not satisfy. Players then take turns making the following actions:

1. Create a structure.
2. Choose *quiz* or *tell*.
3. Spend a guessing chip to guess the rule.

The first action is straightforward; the player builds any structure in whatever manner they choose. Savvy players may choose to build structures with strategic properties, reducing the possibilities of the hidden rule.

On the second part of the turn, the player has the opportunity to find out if their structure satisfies the rule. If they choose *tell*, the leader will tell all players if the structure satisfies the rule. If they choose *quiz*, all players simultaneously guess whether the current player's structure satisfies the secret rule. Each player that guesses correctly is rewarded with a guessing chip.

On the final part of the turn the player has the opportunity to guess the rule. Each guess must be paid for by spending a guessing chip, so a player who has not guessed correctly in any quizzes cannot guess the rule. If the player guesses correctly they win the game. If they guess incorrectly but provide a valid rule, one with no counterexample present, the leader will build a new structure that is a counterexample to their rule. The player may make a guess for each guessing chip that they have accumulated. The game continues until one player correctly guesses the rule and wins the game.

During the game all of the structures are displayed to all players as in Figure 2. For the example given, a possible hidden rule for the game is "The figure must contain exactly one blue piece." A guess that would be invalid is "The structure contains less than four pieces" as a structure not satisfying the rule has three pieces. For a more detailed description of Zendo rules and strategy see [2,3].

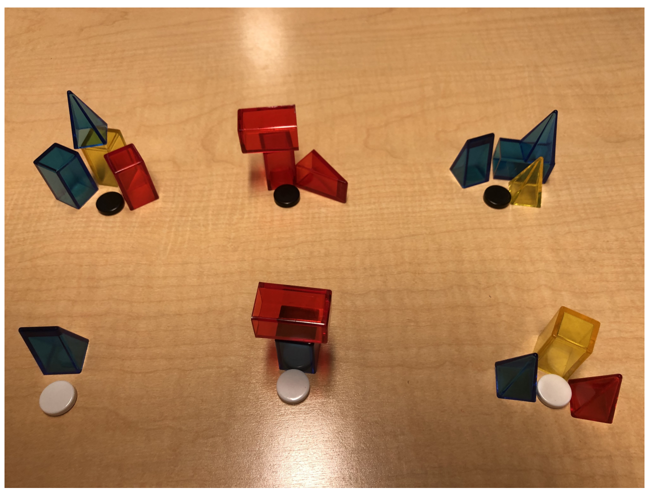


Figure 2. A typical Zendo mid-game setup

We present a variant of Zendo that is designed to facilitate the exploration of patterns and properties with mathematical objects in place of the traditional pieces and structures. A full teacher guide for the game was developed by the second author as part of his senior honors project. That document, which expands significantly on what is presented here, can be found at [1].

2 Mathematical Zendo

The game of Mathematical Zendo has the same framework as classical Zendo but instead of playing the game with blocks, pyramids, and wedges, we use mathematical objects like numbers, shapes, or functions. This flexibility allows mathematics educators to play a fun game and focus on the particular content goals for their lesson. For example, if an educator wants their students to focus on even and odd numbers, they could play Mathematical Zendo where the objects are numbers and rules such as "The number must be a negative and odd" or "The number must be even and bigger than 10." Similar rules could be chosen about lines with positive slope, functions that are increasing, or shapes that are convex. We feel that the rich world of mathematics lends itself well to the very open structure of the game.

In order to illustrate the game we will work through a complete sample game and highlight what we hope participants would be experiencing and thinking throughout. The first topic that we explore is numbers; that is, instead of building a structure on each turn, that player will provide a number. In place of white and black stones we will mark numbers that satisfy the rule with a checkmark (✓) and numbers that do not satisfy the rule with an x-mark (✗).

2.1 A Sample Game

We will now play through a sample game of Mathematical Zendo where the objects of interest are numbers. The examples that students give will all be numbers, and the hidden rule could be a number property such as "The number is positive," or "The number is divisible by 3."

At the beginning of a game the leader picks a secret rule and provides one number that satisfies that rule and one that does not. Assume that the leader has chosen a rule and has given the players the following information:

36	31
✓	✗

The students are now aware that the number 36 satisfies the rule while the number 31 does not. As soon as the students see these numbers, they should immediately start comparing and contrasting the numbers 36 and 31. How are these numbers similar? How are they different? Using information from these questions and comparisons, what could the secret rule be? As a teacher, we would hope that students would be thinking about some of the following:

- 36 is even, 31 is odd
- 36 is composite
- 36 is a multiple of 4, 6, and 12
- 36 is a multiple of 3 and 9
- 36 is a perfect square
- 31 is prime

After the game has been set up by the leader, it is now time for the first player or team of players to take their turn. For the first step, the player chooses a number. For example, player 1 may choose the number 27 to check if the rules "The number is even" or "The number is composite" are valid possibilities. The leader would then include the number the player chose up on the board.

36	31
✓	✗

27

The leader then asks player 1 "*Quiz* or *tell*?" If player 1 chooses "*tell*," the leader will tell the players if the number they gave satisfies the rule. If the player chooses "*quiz*" then each player in the game will have a chance to guess if the number given satisfies the rule. During a quiz, all players will simultaneously guess if the number 27 satisfies the secret rule. This is done by the leader counting down "3, 2, 1, guess." When the leader says "guess", all players will guess simultaneously; after a brief pause to ensure the player or team guesses are clear, the leader will reveal whether the number given does or does not satisfy the hidden rule. In a classroom setting players and the leader can reveal their guesses by a thumbs up or thumbs down, by using colored chips/stones, or by writing their guess on a white board and holding it up. Once the quiz has happened, any player who had guessed the correct answer receives a guessing chip. A guessing chip can later be used as a form of currency in order to make a guess at the secret rule.

Returning to our sample game, assume that player 1 chooses a quiz. Now each player in the game will decide on their guess and get ready for the leader to count down. The leader says, "Okay ready? 3, 2, 1, guess." The guesses are as follows:

	Leader ✗		
Player 1	Player 2	Player 3	Player 4
✓	✗	✗	✓

Therefore, player 1 and player 4 both guessed that the number 27 satisfies the rule and player 2 and player 3 guessed that the number 27 does not satisfy the rule. Simultaneously, the leader has revealed the truth, that the number 27 does not satisfy the hidden rule. The players who have correctly guessed earn a guessing chip. The leader can pass out a token that represents a guessing chip, or they can mark guessing chips under the player's name with tallies on the board:

	Leader ✗		
Player 1	Player 2	Player 3	Player 4
	I	I	

The teacher would then update the board by marking the number 27 with an x-mark:

36	31 27
✓	✗

With this new information, what could the hidden rule be? Given that the number 27 does not satisfy the hidden rule, students should have eliminated a few possibilities from their list of potential hidden rules. We hope they are thinking about the following:

- 36 is even, 31 is odd
- ~~36 is composite~~
- 36 is a multiple of 4, 6, and 12
- ~~36 is a multiple of 3 and 9~~
- 36 is a perfect square
- ~~31 is prime~~

The students should have ruled out that the hidden rule could be "The number has to be composite" due to 27 being composite and not satisfying. At the same time, 31 being prime is no longer relevant due to 27 not satisfying the rule and being composite. Also, 27 is a multiple of 3 and 9, eliminating those factors as potential hidden rules.

The third and final part of a player's turn is that they have the ability to trade in a guessing chip they have earned during a quiz in order to take a guess at the hidden rule. If a player chooses not to make a guess, they will pass to the next player's turn. In the sample game, player 1 has yet to earn a guessing chip and therefore must pass to player 2. Player 2 starts their turn by giving a number. Assume player 2 gives the number 11.

36	31 27
✓	✗

11

The leader then asks player 2 "*Quiz* or *tell*?" Player 2 realizes that they already have a guessing chip and does not want for other players to be able to gain more, so they choose *tell*. The leader then reveals that the number 11 does not satisfy the rule:

36	31 27 11
✓	✗

Player 2 does have a guessing chip from the quiz on player 1's turn and thus can choose to trade their guessing chip in to make an attempt at guessing the hidden rule. Player 2 chooses to guess that the hidden rule is "The number must be an even number." When a guess is made, the leader asks for all players to check if the guess is valid. If the guess is, in fact, valid and there are no counterexamples on the board, then one of two things happen:

1. If the guess made by the player matches the hidden rule, the player wins the game.

2. If the guess made by the player does not match the hidden rule, the player loses their guessing chip and the leader will provide a counterexample to prove that the guess is incorrect.

Here, the guess that player 2 made is incorrect so the leader then gives a counterexample to prove that the guess is incorrect. The number 25 is a counterexample because it does not satisfy the guessed rule, but it does satisfy the hidden rule.

36 25	31 27 11
✓	✗

Now that the leader has revealed that the number 25 satisfies the hidden rule, students should have eliminated even more possibilities from their list of potential hidden rules. They could now be thinking about the following:

- ~~36 is even, 31 is odd~~
- ~~36 is composite, 31 is prime~~
- ~~36 is a multiple of 4, 6, and 12~~
- ~~36 is a multiple of 3 and 9 while 31 is not~~
- 36 is a perfect square
- ~~31 is prime~~

Based on the information available thus far, students should have eliminated "The number must be even" as the hidden rule since the leader's counterexample proved that rule to be infeasible. Additionally students should have eliminated *a multiple of 4, 6, or 12* as a potential hidden rule due to 25 not being divisible by 4, 6, or 12.

Since player 2 does not have any more guessing chips, it is now player 3's turn. Player 3 recognizes that both 36 and 25 are perfect squares while 31, 27, and 11 are not and chooses 100 as their example to test if the number must be a perfect square. The leader then puts 100 up on the board and asks the player "*Quiz* or *tell*?" Player 3, like player 2, realizes that others in the game do not have guessing chips and decides *tell*. The leader then reveals the following:

36 25 100	31 27 11
✓	✗

Player 3 sees that 100 does, in fact, satisfy the hidden rule, making them confident in their conjecture and they decide to trade in a guessing chip to make a guess. Player 3 guesses, "The number must be a perfect square." The leader then asks all players to check to make sure this is, in fact, a valid guess. Everyone involved confirms that 36, 25, and 100 are perfect squares while 31, 27, and 11 are not, therefore, player 3's guess is a valid guess. The teacher reveals to the player that this guess is correct! Player 3 has won the game.

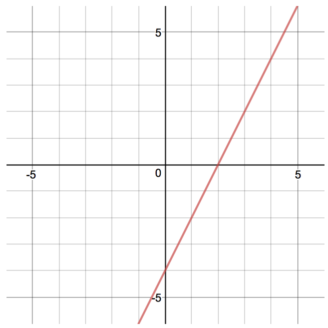
3 Selecting Rules and Objects

One of the most engaging aspects of Zendo is the nearly complete freedom that the leader and the players have to explore mathematical ideas and create rules. Any mathematical object - lines, polygons, functions, shapes - could be the basis for an engaging and thought provoking round of play. As exciting as this is, it is easy to devise rules that *seem* to form a solid foundation for a game, but quickly can become a confusing morass for the players. For example, a rule such as "The number must be positive and a perfect square or even" is ambiguous and can result in confusing game play.

In this section, we will discuss the process of selecting objects and rules. We start with a discussion around example representation that arises from considering linear functions as the object of interest.

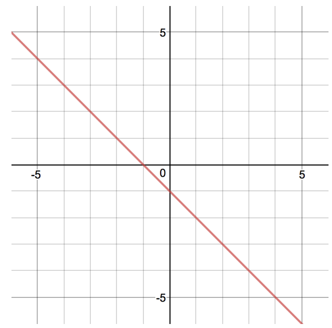
3.1 Linear Function Zendo and Representation

At the beginning of a game the leader picks a secret rule and provides one linear function that satisfies that rule and one that does not. For example, assume that the leader has chosen a rule and has given the players the following information:



(a) $f(x) = 2x - 4$

✓



(b) $g(x) = -x - 1$

✗

The students are now aware that the linear function created by the equation $y = 2x - 4$ satisfies the rule while the linear function created by the equation $y = -x - 1$ does not. However, the leader could have chosen different representations for this information; they could have included the graphs with no equations, or equations with no graphs. They could have provided a slope and a point, or even just two points, leaving it up to the players to fill in the details. There is a lot of freedom in how examples are represented and can be modified to align with particular curricular goals.

3.2 Questions and Principles for Rule Selection

When constructing or selecting rules, there are a few questions that are worth considering.

1. **What is my goal?**

   Like many curricular design pursuits, we feel that is is worthwhile to take a backwards design approach to rule selection and construction. Does the leader want to highlight a certain property? Give a chance to practice some key terminology? Introduce a new idea or definition? There are more worthwhile goals than can be listed practically here, but knowing what a game could accomplish for the players is a great first step. One option is to use local or state standards as inspiration - they can be great places to find ideas and in a classroom setting can allow a leader to clearly align Mathematical Zendo with curricular goals. As an example, in the partial game from Section 3.1 the teacher may have a goal of having students explore algebraic and/or graphical representations of linear functions. This may impact how they construct examples or otherwise construct prompts throughout the game.

2. **Where might this go?**

   There are a lot of directions that a group of energetic, creative players can go from a set of examples that the leader might think are straightforward. They might come up with unanticipated examples, or latch onto a set of common properties that appear in the set of examples so far. The leader can never be sure how a game might play out, but thinking through some possible diversions can smooth game play considerably. When working with a group of players that are familiar, a leader will often benefit from their knowledge of those players' conceptual understandings and other skills, which factor heavily into their approach to certain rules and objects.

3. **What examples might be useful?**

   Presenting an illuminating initial example and non-example of the secret rule is an important part of a good rule. If chosen poorly, players might become stuck on an incorrect idea, building frustration. Beyond these initial two examples, it is also good to have some feel for some types of examples or non-examples that might guide the players later in the game.

3.3 Guess Libraries

There are many options for mathematical objects to build a game upon, and some that may seem perfect at first can lead to games that are frustrating, to say the least. For instance, in our experience one of the most alluring mathematical objects to consider are polygons. Why not? There are numerous rules that come to mind - "has a right angle," "has two parallel sides," "is a pentagon."

The challenge in this case, however, is that the the polygons that students will often draw as guesses are either extremely unusual (and hence usually unhelpful) or overlap in so many ways that groups may get off track or disengage. There is also an issue with trying to determine the features of what may be an inexact drawing. Is that *really* a right angle?

To address these challenges, we introduce the idea of an *example library*, which is a collection of pre-created examples that have been assembled. In our conception, these examples are generally printed out and put in a bag to allow students to select an example randomly, but we acknowledge that there are many ways to utilize this general idea. Students take an example from the bag on their turn, which allows a leader to not only maintain some level of certainty about how the game might progress, but also allow for faster game play. We have made available an example library for polygons at [1].

3.4 Some of Our Favorite Rules

Table 3.4 gives some examples of rules that we find interesting for various reasons. Some have led to rich games with our students, while others lend themselves to exploration of multiples representations. Many are designed to illuminate concepts or definitions that may be challenging to master for some groups of students. It is our hope that this limited selection spurs the reader to explore and create the nearly limitless possibilities inherent in the game of Mathematical Zendo.

Object	Example Rule(s)
System of Linear Equations	Has exactly one solution; Has no solution.
Function of a Real Variable	Is an (odd/even) function; Has a (vertical/slant/horizontal) asymptote; (Is/Is not) integrable on $[0, 1]$; Is one-to-one, has a graph that crosses the x-axis exactly once.
Pair of Real Numbers	Have a product/sum/difference less than one; Have an integer mean.
List of Rational Numbers	Is (increasing/decreasing); Sums to 1; Consecutive values differ by less than $\frac{1}{2}$.
Polynomial of Degree ≤ 3	Has three distinct roots; Has 0 as a root; Has a saddle point.
Numbers	Is one more than a multiple of 3; Is in the interval $[a, b]$.

4 Tips and Tricks for Effective Facilitation

While leading Mathematical Zendo during Math Circle events and in the classroom, we found ourselves constantly refining our techniques and strategies to successfully implement the game. After many events, we decided that there were a few things that a leader should always try to do to ensure that the game runs smoothly. We have compiled a list of these tips and tricks, hoping to help future leaders of this game. We have also compiled a list of tips and tricks to give to students along the way. These "tips" that we can give students will help them improve their game play, as well as their mathematical thinking.

4.1 Tips For Leaders

1. Keep the game moving!

   We have found that the best thing the leader of the game can do to keep the game interesting and entertaining is to keep the game moving. It is helpful to prompt students to give an example as soon as the previous player ends their turn. The first step is the easiest to do; the student can give any example! If players are consistently taking an extended period of time trying to give the perfect example remind them that there is no wrong answer. No matter what example they give, they will find out more information that can be used to formulate a guess later on. Right after a player gives an example, ask "*Quiz* or *tell*." Players should be allowed 15-20 seconds to formulate a guess during a quiz and then the quiz should be held.

   When leading a game of Zendo with a large number of players we have found it beneficial to allow all teams to spend their guessing chips during the guess period on each turn. It is easy for players to become disengaged when they feel their turn is too far away. Allowing them to guess each turn, proceeding in order from the team that most recently gave an example, keeps participants motivated and encourages discussion.

2. Give counterexamples some thought: guide players or challenge players.

   The counterexample provided after a valid but incorrect guess can have a big impact on the game. It can be used to point the players in the direction of the rule, or can be used in order to give little to no information. This is a judgement call made by the leader that can bring the game to a quick ending or try and further game play. For example, if the objects of interest are numbers and the hidden rule is "The number must be prime," giving a counterexample that satisfies the rule such as 2, 3, 5, 7, 11, or 13 may tend to give away that the rule involves prime numbers. If the leader wants to make it less obvious, a prime such as 73, 97, 127, 149, or 173 would be a great counterexample that would not immediately hint that the rule involved prime numbers. If the game is working with divisibility rules, a great counterexample can be 0 if it is not already on the board. For example, consider the rule "The number must be divisible by 7." Putting up a 7, 14, or 21 may give that away quite fast, but a 0 will not typically give away what the divisibility rule is, and can open up a discussion with the students about "Is 0 actually divisible by 7? Why?"

3. Always check the board.

   The leader of the game has the responsibility to make sure that each example given is correctly labeled. Make sure to consistently check what has already been put up to make sure each has been assessed correctly. If the leader notices that an example has been incorrectly labeled, change it immediately and make everyone playing aware of the change as this may drastically alter the game. Also, checking the board consistently can help determine valid guesses that are not the hidden rule. Doing this can prepare the leader for guesses that players may give and can allow for them to have counterexamples prepared.

4. Have a plan, and know your space.

   A leader will know their area and supplies better than anyone else. When it comes to players earning guessing chips, something a leader will want to think about is how to record how many guessing chips a player has. One method is passing out physical tokens that can be used as a form of currency in order to give a guess. Tokens seem to work best when there is another person in the room to assist passing these pieces out such as a student helper, a teaching aid, etc. Another successful method (recommended for leaders that are by themselves) that does not require physical pieces is record the number of guess chips up on the board. The leader can put the player's names at the top of the board and recording a tally for each guessing chip they have. Also, when denoting whether an example satisfies the rule or not, the leader has many options. They can choose to draw check marks and x-marks, use magnetic shapes/pieces, or different colored markers.

5. Choose a rule of appropriate difficulty.

   In order to keep players interested and involved in the game, choosing an appropriate rule is important. If players seem to be having an easy time with the current rule, it would be advised to use a more challenging rule in the following game. If the students seem to be struggling or cannot solve the hidden rule, a drop in difficultly may be needed. Be careful not to mistake being challenged for not being able to figure out a rule. We as leaders want the players to often times be challenged and want for them to have to persevere through problems in order to open themselves up to a positive learning experience.

6. Team roles may be helpful.

When running Mathematical Zendo, it can often be helpful to have each team of players assign roles within the group. This can help to speed up the process of guessing during "*Quiz* or *tell*," putting up examples, or giving a guess on the third part of a team's turn. Roles that we recommend include someone who reveals a group's guess during "*Quiz* or *tell*," someone who takes down notes, someone who gives an example at the beginning of a turn, and someone who gives a guess at the rule on the final part of a team's turn. If there are more than four members in a group, then two people could share a role.

4.2 Tips For Students

1. Players should think about guesses before their turn.

   It is a good idea to prompt players to think about rule guesses before their turn comes up. They can write down valid guess options or reoccurring attributes on a piece of scrap paper. Having players organize their observations and thoughts can assist with keeping the game moving by reducing wait time between guesses, and as an added benefit can reinforce an important organizational skill. At the same time, as a leader, we want to be careful not to feel a need to rush the players' deeper thinking and problem solving. The game is designed to evoke critical thinking and analyzing, and it is incumbent on the leader to maintain a balance of moving the game and allowing for good math to be done.

2. Use the initial example to test thoughts/guesses.

   The first part of a turn can be important for many reasons. First of all, no matter what the example is, some information about the hidden rule will be unveiled. At some point during the turn it will be revealed if the example given satisfies the rule, giving the players more information. Therefore, giving an example at the beginning of a turn can be a helpful tool to test out conjectures about the hidden rule. For instance if the player is thinking that the rule may be "The number must be a multiple of 3," then a good number to give would be any multiple of 3. Carefully selecting examples can be crucial to being able to eliminate possible hidden rules, thus narrowing down the list of possible guesses. Also, using an example to test more than one possible hidden rule can be greatly beneficial. The goal of the game is to guess the hidden rule first so the fewer turns, the better.

3. Have a strategy when choosing "*Quiz* or *tell*."

The choice made during the "*Quiz* or *tell*" part of a turn can be crucial to game strategy. If a player already has multiple guesses, or more guesses than the other players, then choosing "*tell*" may be the best option. Remember that during a quiz, each team has the chance to earn a guessing chip, so choosing "*tell*" is the only way to guarantee other players will not earn more. Conversely, if a player does not have any guessing chips then choosing quiz is highly recommended. Earning a guessing chip through a quiz could allow a player to win the game.

4. Pay attention to other players turns.

   A valuable aspect to Mathematical Zendo is that each and every turn can assist players, whether it is their turn or not. A good player will constantly be checking the different examples on the board and thinking about hidden rule possibilities and preparing to select examples that allow them to explore those rules. Also, when it comes time for a quiz, players want to be ready for it. As soon as an example goes up on the board, players should be asking themselves if they believe the example satisfies the rule. Even if a player chooses "*tell*", players can make an internal guess and check the answer when the teacher gives the truth. Being an active and present player is crucial to being successful in Mathematical Zendo!

5 Feedback from Testers and Conclusion

While developing Mathematical Zendo, we ran the game during many Math Circle events, as well as in the middle school and high school classroom. By consistently running the game, we were able to receive feedback from players and refine the game to improve it for the next session. In total, we have run Mathematical Zendo at 18 events, for around 600 people and in 3 undergraduate and graduate courses for pre-service and in-service mathematics teachers.

As part of early testing, we distributed the survey found in the Appendix to each student that participated. The data not only gave us insight into how to improve the game, but also if students were enjoying the game as a whole. A total of 83 out of 85 responding students answered yes to "Did you enjoy this game?" which gives us a 97.6% rate of positive feedback. Students wrote comments such as "Fun and interesting!", "Cool game!", and "Fun game, love how I can use this game for anything!" Along with the data, we have received numerous positive reviews from teachers, administrators, and students who tested the game outside of our facilitation.

Thoughtfully selected objects and rules, supported by an enthusiastic leader that delivers meaningful hints and promotes energetic gameplay, are crucial to maximizing the experience of playing Mathematical Zendo. Indeed, we cannot overstate the importance of proper and coordinated facilitation to a successful game. Students will often times react to the energy and enthusiasm of the person running the game, which can mitigate frustration and support creativity and critical thinking. It is our sincere hope that the reader enjoys the game, and has as much fun playing it with your students as we have ours.

Acknowledgements

The authors would like to thank Looney Labs for their permission to explore and write about Mathematical Zendo. We would also like to thank the hundreds of students and teachers whose enthusiastic playtesting allowed us to refine the game to its current form.

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Appendix

This survey will give us information about your interest in the game Mathematical Zendo. Your participation in this survey is completely voluntary. You are free to decline to answer any or all questions you do not wish to answer for any reason. You will receive no benefits from filling out this survey, but it may improve the experience for future players. Any answers you choose to provide will remain anonymous, and aggregated results will be studied and presented to future audiences. By continuing to fill out this survey you agree to these terms.

Survey Questions

1. Did you enjoy this game?
   YES NO

2. Would the game be more enjoyable if you were the leader?
   YES NO

3. Did you find the turn summary card helpful?
   YES NO

4. Rate the difficulty of each rule played $1 - 5$. (1 - Easy, 5 - Difficult)

   (a) Rule 1: ____________________

   Difficulty: 1 2 3 4 5

   (b) Rule 2: ____________________

   Difficulty: 1 2 3 4 5

(c) Rule 3: ______________________________________

Difficulty: 1 2 3 4 5

(d) Rule 4: ______________________________________

Difficulty: 1 2 3 4 5

(e) Rule 5: ______________________________________

Difficulty: 1 2 3 4 5

(f) Rule 6: ______________________________________

Difficulty: 1 2 3 4 5

5. How can we improve the turn summary card?

6. Did you find any part of the game or instruction confusing? If so, which part?

7. Additional Comments: