

BENDO

A Movement Game for Exploring
Inductive Reasoning

Simon Pfeil, Angelo State University Math Circle

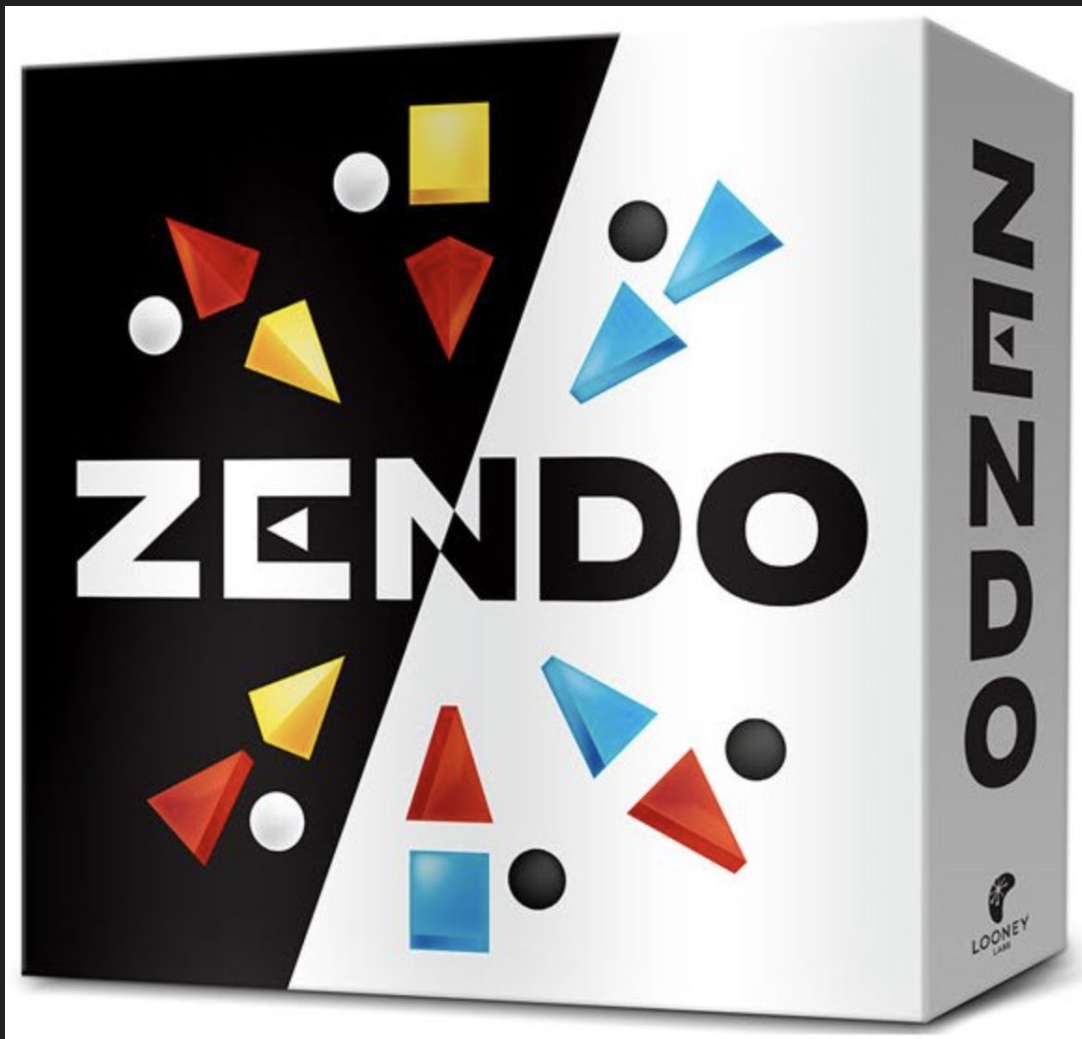
ASU Math Circle

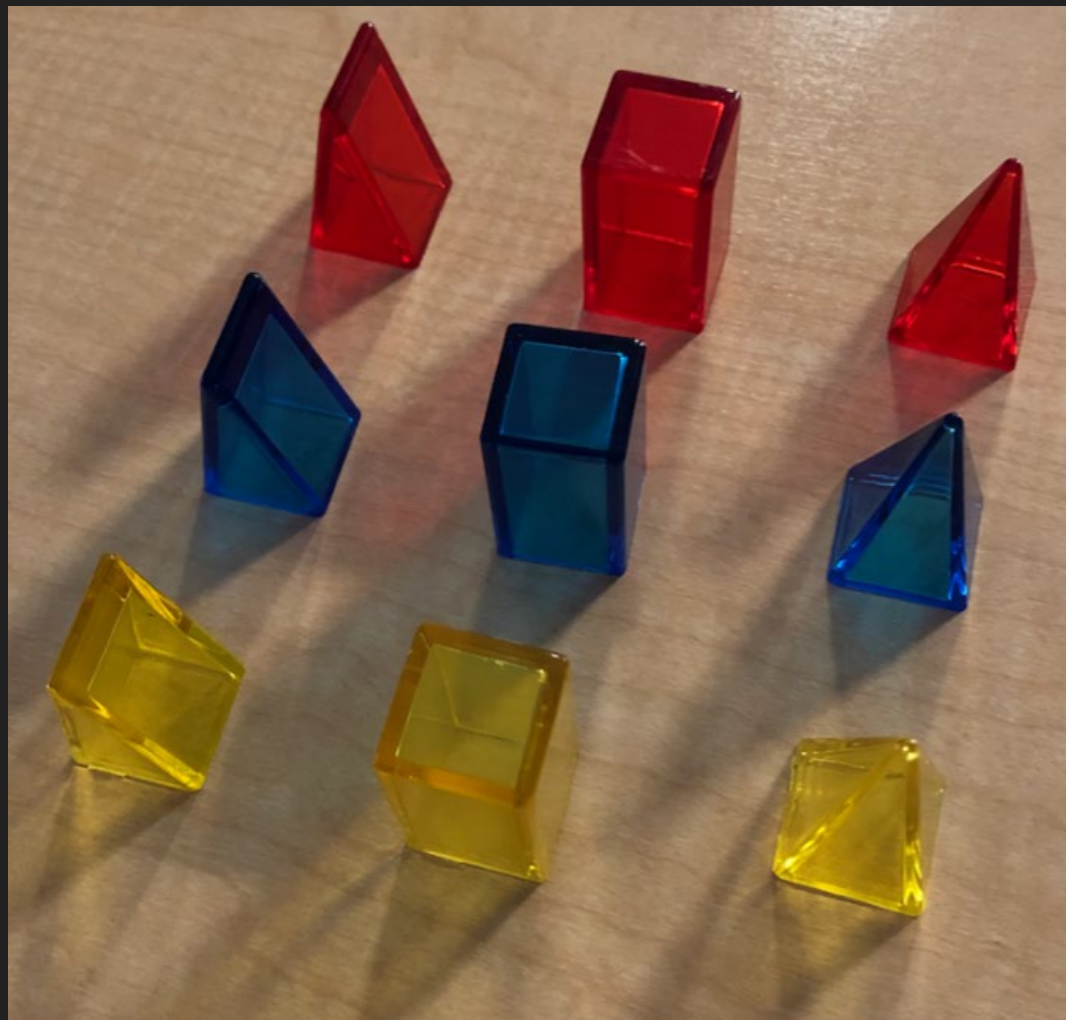
- Started in Spring 2023
- Serves 3rd - 6th graders
- Approx. 20 students per circle
- Led by ASU faculty and undergraduates

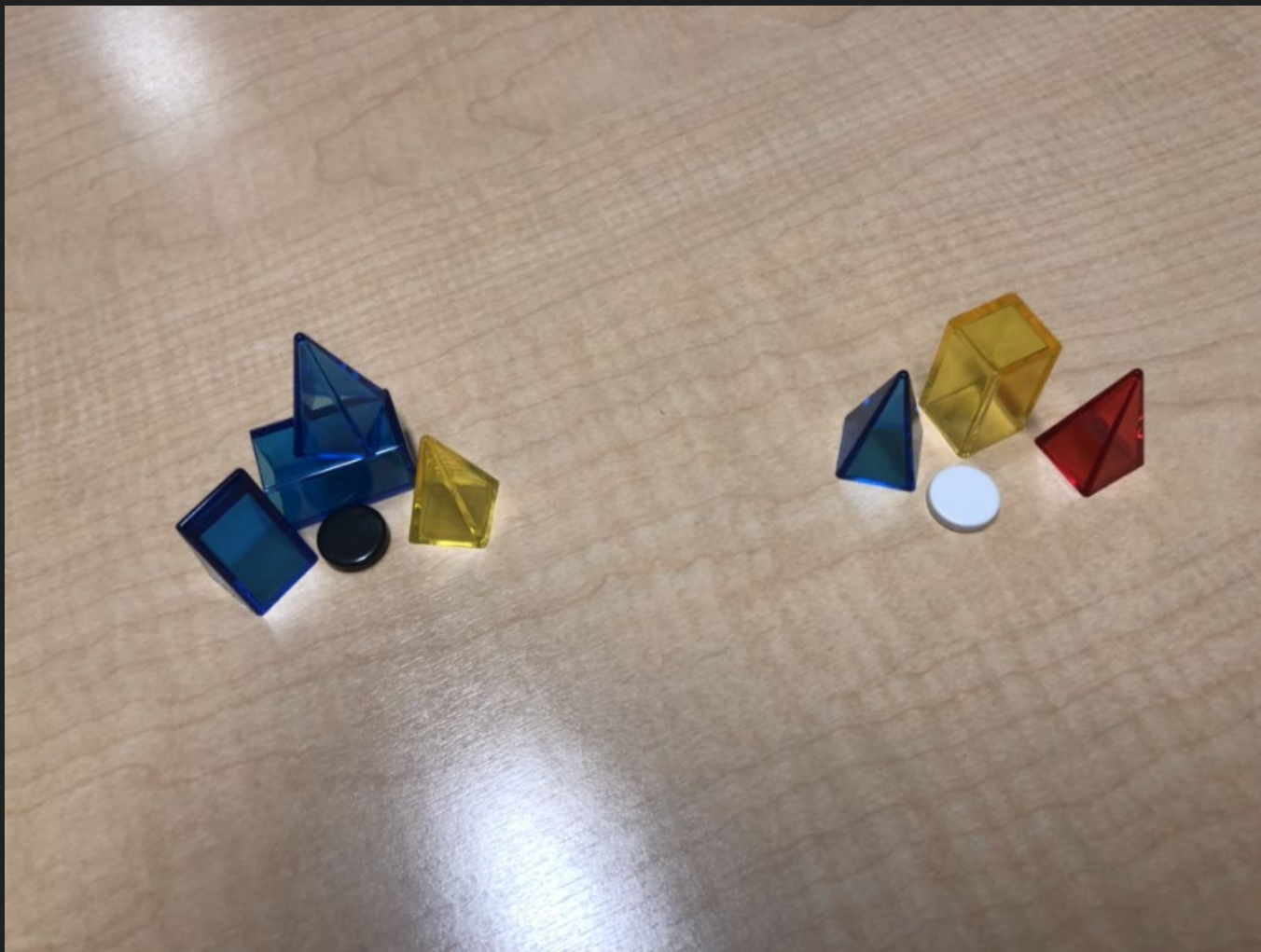


What is Zendo?

- Kory Heath, Andrew Looney
- Published in 2001
- Updated in 2017

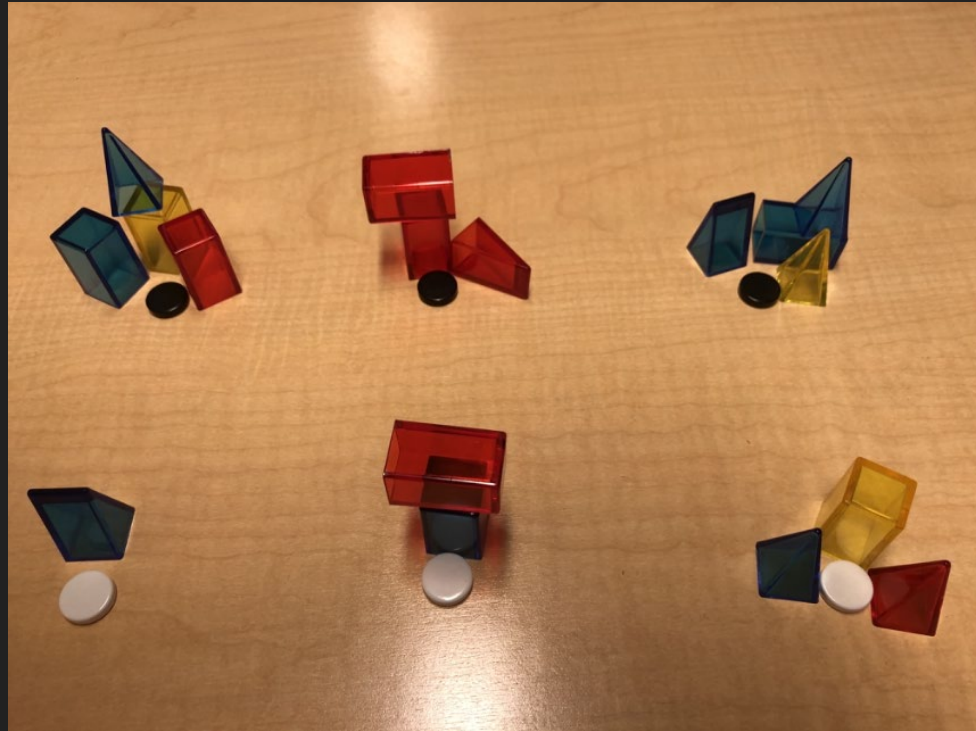






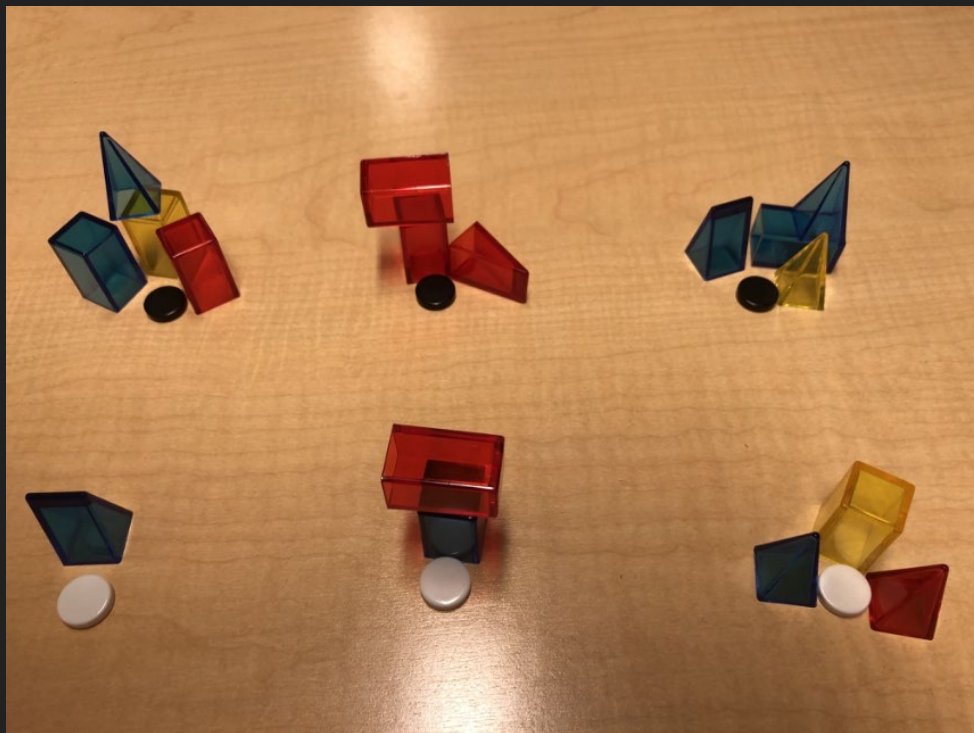


What is the secret rule?





What is the secret rule?



The structure must contain *exactly one blue piece*.



Want more math?



Want more math?

Mathematical Zendo: A game of patterns and logic

Philip DeOrsey ^{*a}, Corey Pooler^b, and Michael Ferrara^c

^aWestfield State University

^bWillow Hill School

^cUniversity of Colorado Denver

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



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Want *even more* math?

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The Control Zendo: A Game of Inductive Logic for Teaching Automatic Control

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² *Uniped, University of Stavanger, Norway*

Abstract: Board games and card games have been used with some degree of success in the implementation of active strategies for education, since they stimulate problem solving and increase the learning and engagement of the students. This paper shows how the mechanics of the popular game Zendo have been adapted to teach elements of a basic automatic control course at the University of Stavanger. The result is the Control Zendo, a game of inductive logic in which a hidden rule related to different system's properties (e.g., linearity, time-varyingness or number of input and output variables) must be guessed. Implementational issues and the feedback received by the students who played the game in Spring 2022 are discussed.

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Keywords: Control education, educational games, logic game, pattern recognition



How to play BENDO



How to play BENDO

- Facilitator chooses and demonstrates a secret rule



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 - They provide two example poses,



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 - They provide two example poses,
 - one that does follow the secret rule, and



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How to play BENDO

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 - They provide two example poses,
 - one that does follow the secret rule, and
 - one that does not follow the secret rule.
 - All participants must copy each pose to the best of their ability



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- Participants are asked to share observations about the differences between the two poses



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- Taking turns, each participant offers their own pose



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- Taking turns, each participant offers their own pose
 - As before, every participant must copy the pose



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- After each participant gets a turn, they confer and try to guess the secret rule



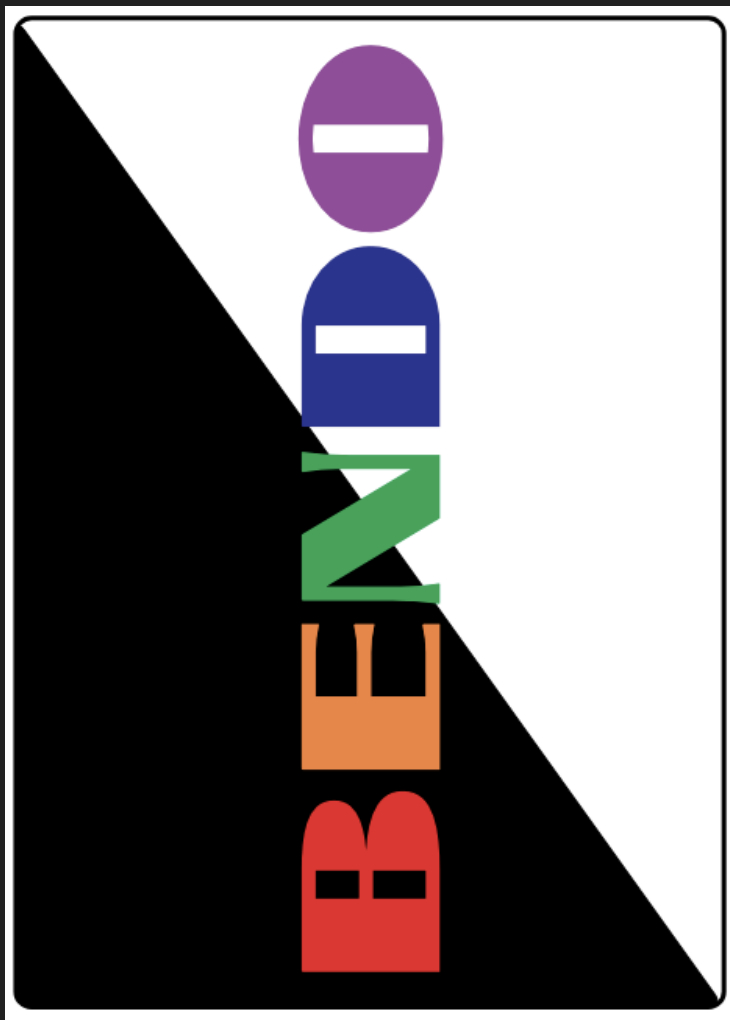
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 - As before, every participant must copy the pose
 - The facilitator then tells the participants whether or not that pose follows the secret rule
- After each participant gets a turn, they confer and try to guess the secret rule
 - If the guess is correct, they win!
 - If the guess is incorrect, they are given a counterexample



A pose must contain

EXACTLY 1

EXACTLY 2

AT LEAST 1

PEACE SIGN

THUMBS UP

POINTING FINGER

Easy

1

A pose must contain

EXACTLY 1

EXACTLY 2

AT LEAST 1

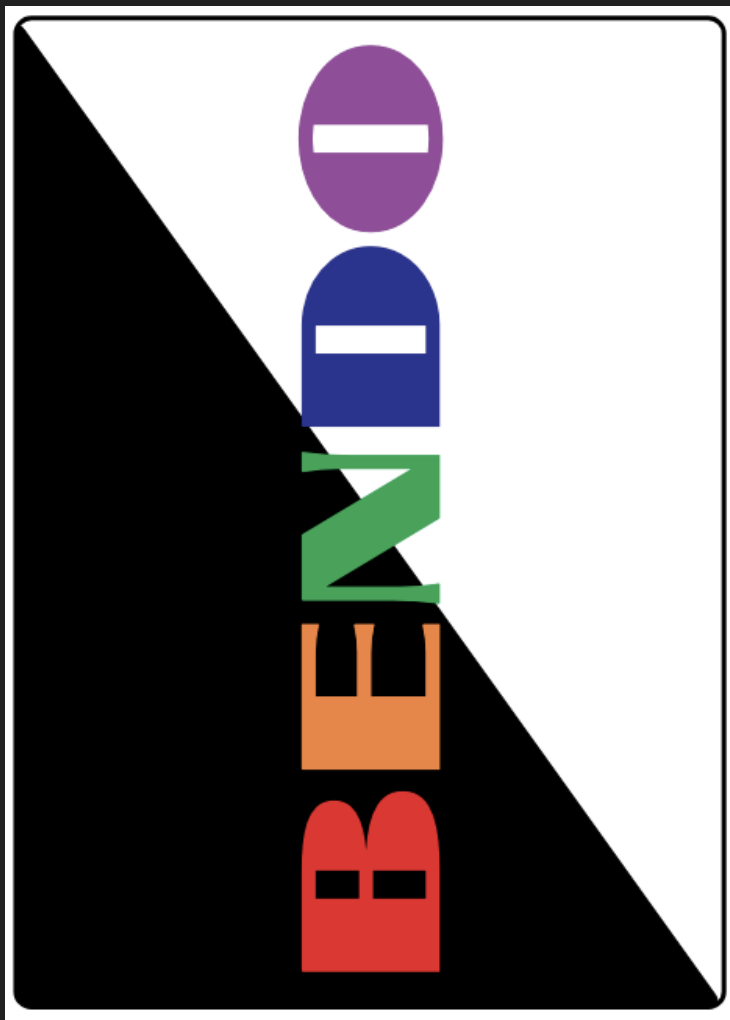
PEACE SIGN

THUMBS UP

POINTING FINGER

Easy

1



A pose must contain

EXACTLY 1

EXACTLY 2

AT LEAST 1

hand(s)

ABOVE

BELOW

your head

Easy

4

A pose must contain

EXACTLY 1

EXACTLY 2

AT LEAST 1

hand(s)

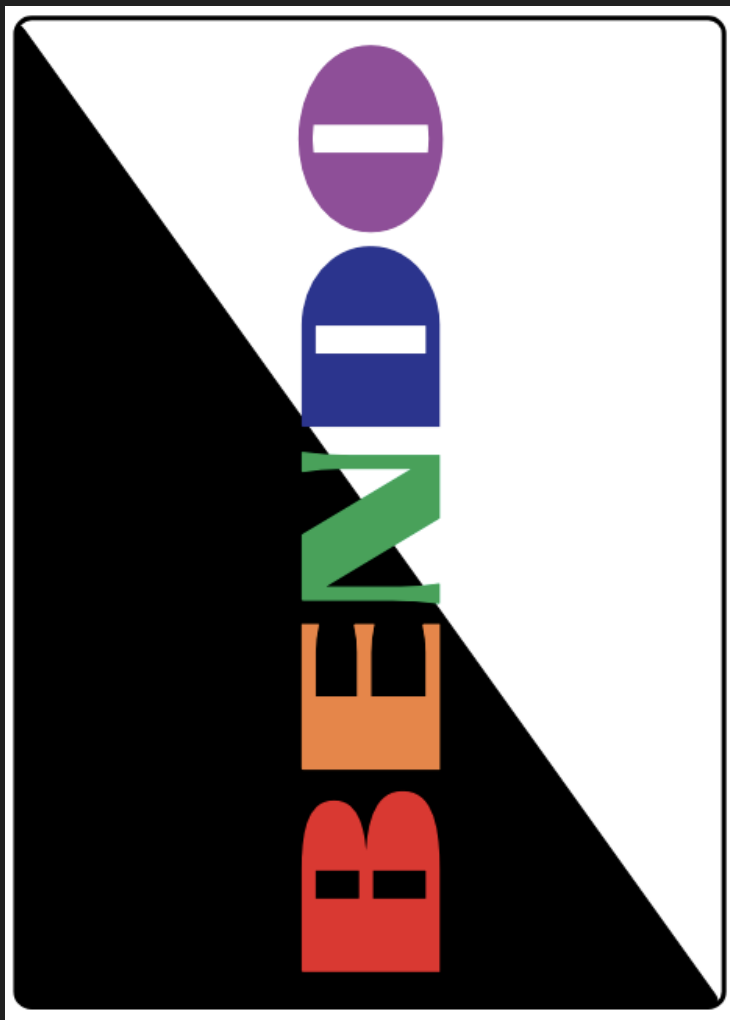
ABOVE

BELOW

your head

Easy

4



A movement must be
no more than
ONE SECOND LONG

DECOY

DECOY

Medium

11

A movement must be
no more than
ONE SECOND LONG



DECOY



DECOY

Medium

11

A pose must contain

EXACTLY 1

EXACTLY 2

AT LEAST 1

PEACE SIGN

THUMBS UP

POINTING FINGER

Easy

1

A pose must contain

EXACTLY 1

EXACTLY 2

AT LEAST 1

bent

ELBOW(S)

KNEE(S)

Easy

2

A pose must contain

at least one

CLOSED

OPEN

FIST

MOUTH

EYE

Easy

3

A pose must contain

EXACTLY 1

EXACTLY 2

AT LEAST 1

hand(s)

ABOVE

BELOW

your head

Easy

4

A pose must contain

a(n)

ANGRY

HAPPY

SAD

face

DECOY

Medium

5

A pose must contain

a

HAND

FOOT

in contact with

another body part

DECOY

Difficult

6

A movement must contain

EXACTLY 1

EXACTLY 2

AT LEAST 1

PEACE SIGN

THUMBS UP

POINTING FINGER

Easy

7

A movement must contain

EXACTLY 1

EXACTLY 2

AT LEAST 1

HOP

SHRUG

KICK

Easy

8

A movement must contain
at least one

LOOK

POINT

STEP

to the

LEFT

RIGHT

Easy

9

A movement must contain
a(n)

ANGRY

HAPPY

SAD

face

DECOY

Medium

10

A movement must be
no more than

ONE SECOND LONG

DECOY

DECOY

Medium

11

A movement must contain
a

HAND

FOOT

in contact with
another body part

DECOY

Difficult

12



Reflections on BENDO

- As with all Zendo-like games:
 - It necessitates engagement through inquiry
 - It requires a systematic approach to problem solving
 - It shows the value of making a conjecture, even when it is “wrong”



Reflections on BENDO

- As with all Zendo-like games:
 - It necessitates engagement through inquiry
 - It requires a systematic approach to problem solving
 - It shows the value of making a conjecture, even when it is “wrong”

- For BENDO, specifically:
 - There are no material requirements
 - The only facility requirement is sufficient space in which to move
 - It allows students to utilize a different set of skills than more traditional activities
 - It gives students license to be silly

References

- Heath, Kory; Looney, Andrew (2017); “Zendo,” Looney Labs
- DeOrsey, Philip; Pooler, Corey; and Ferrara, Michael (2021) "Mathematical Zendo: A game of patterns and logic," Journal of Math Circles: Vol. 2: Iss. 1, Article 2, <https://digitalcommons.cwu.edu/mathcirclesjournal/vol2/iss1/2>.
 - The figures demonstrating the example Zendo game come from this paper
- Rotondo, Damiano; Jimarkon, Pattamawan; Fjereide, Didrik Efjestad (2023); “The Control Zendo: A Game of Inductive Logic for Teaching Automatic Control”, IFAC-PapersOnLine, Volume 56, Issue 2, Pages 4675-4680, ISSN 2405-8963, <https://doi.org/10.1016/j.ifacol.2023.10.984>.
- SAISD School Images:
 - https://resources.finalsite.net/images/f_auto,q_auto/v1574356129/saisdorg/uydykasxrdcged9mmnno/HolimanElementary.jpg
 - https://resources.finalsite.net/images/f_auto,q_auto/v1574355862/saisdorg/xddgxidjgjh8abosfdh/CrockettElementary.jpg
- Zendo Game Image, W. Eric Martin, <https://boardgamegeek.com/image/3678087/zendo>

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Thank you!

A pose must contain

EXACTLY 1

EXACTLY 2

AT LEAST 1

PEACE SIGN

THUMBS UP

POINTING FINGER

Easy 1

A pose must contain

EXACTLY 1

EXACTLY 2

AT LEAST 1

bent

ELBOW(S)

KNEE(S)

Easy 2

A pose must contain
at least one

CLOSED

OPEN

FIST

MOUTH

EYE

Easy 3

A pose must contain

EXACTLY 1

EXACTLY 2

AT LEAST 1

hand(s)

ABOVE

BELOW

your head

Easy 4

A pose must contain
a(n)

ANGRY

HAPPY

SAD

face

DECOY

Medium 5

A pose must contain
a

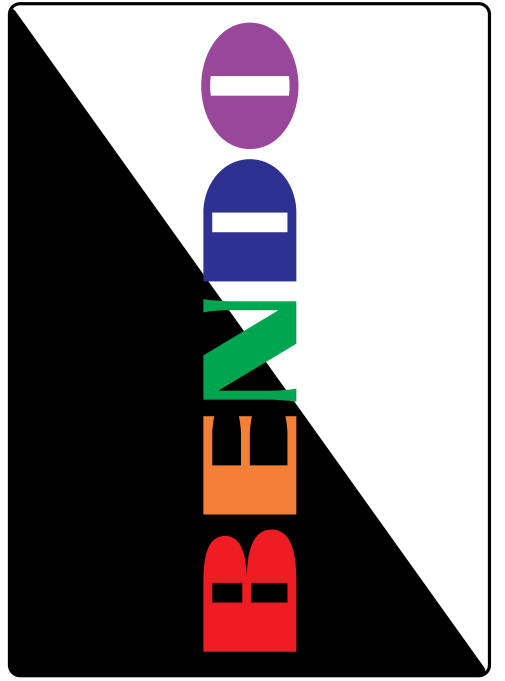
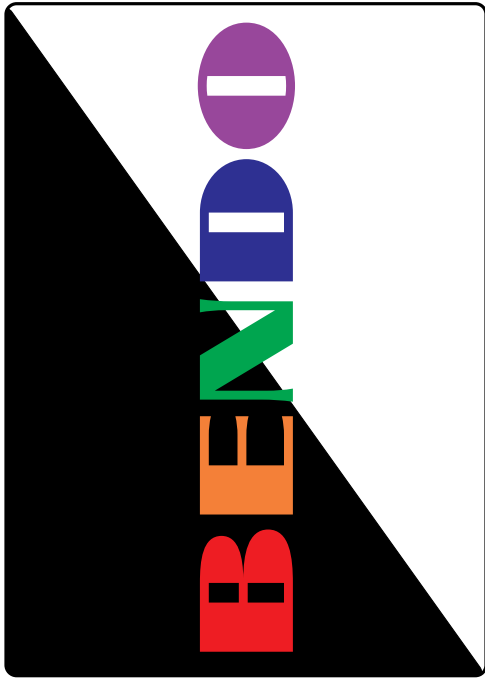
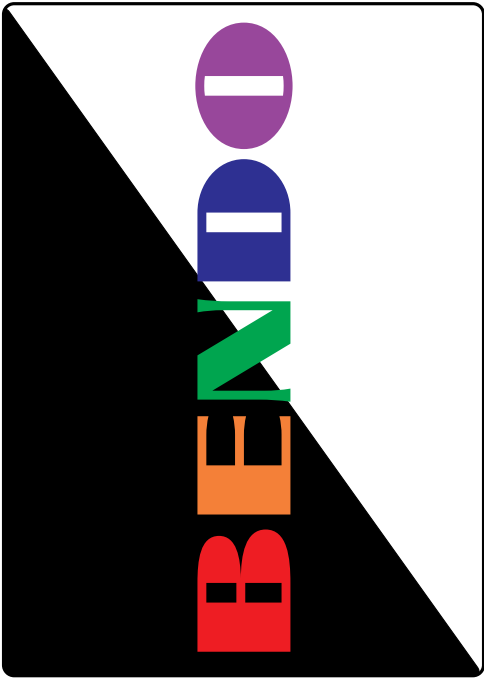
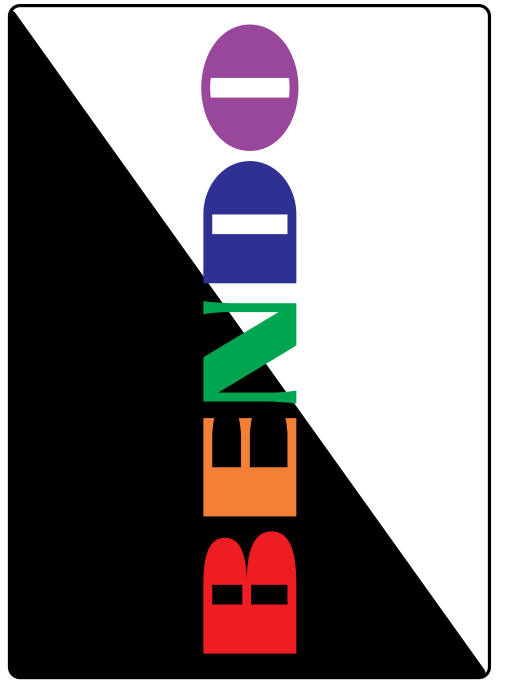
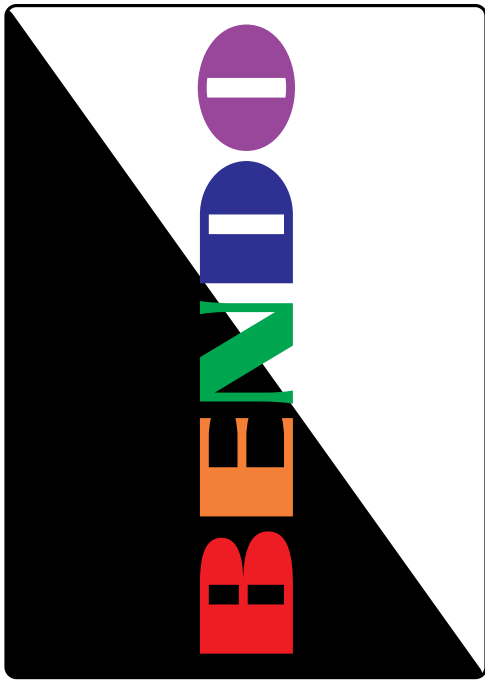
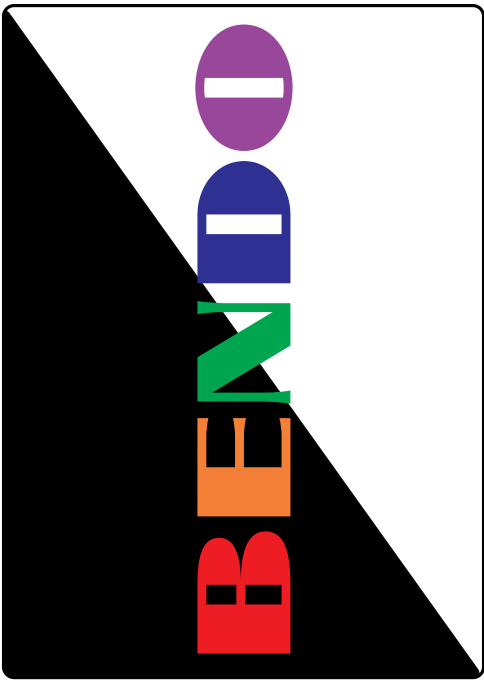
HAND

FOOT

in contact with
another body part

DECOY

Difficult 6



A movement must contain

EXACTLY 1

EXACTLY 2

AT LEAST 1

PEACE SIGN

THUMBS UP

POINTING FINGER

Easy

7

A movement must contain

EXACTLY 1

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AT LEAST 1

HOP

SHRUG

KICK

Easy

8

A movement must contain

at least one

LOOK

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STEP

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RIGHT

Easy

9

A movement must contain
a(n)

ANGRY

HAPPY

SAD

face

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Medium

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Difficult

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