Challenging the odds

Integration

21st Century Themes: Critical thinking

Concepts for STEM Disciplines		
	Mathematics Probability Statistics Random variables	**Science** Forces Gravity Centre of mass
	Technology GeoGebra 3D printing Tinkercad	**Arts** ----------

Prerequisite Knowledge

Mathematics
Probability distribution of a regular dice.

Science Education
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Information Technologies
Basic use of GeoGebra.

Learning Outcomes

Grade Level: 13-17 years old
Duration: 180 minutes

Learning Outcomes for Mathematics
Understand probability in forms of fractions and percentages (⅙ or 16.6%).
Use different notation to refer to probabilities.
Distinguish between absolute and relative frequency.
Understand and use P() notation.
To analyse a series of outcomes (ie. from the collection of experiential data and drawing conclusions).
Define 'bias' and explain its relevance in for example gambling.
Draw connections to real life problems.

Learning Outcomes for Science Education
Forces.
Gravity.
Centre of mass.

Learning Outcomes for Information Technologies
3D printing design.

Real World Cont

Problem Situation
What is the expected outcome when we throw a dice 1000 times?
How many times do you expect the number 5 to come when the dice is thrown 60 times? Why?
Is there a way to tell when a game (dice) is not fair?
With the dice as a 3D object, the random attempts can be played through very easily and you don't have to imagine throwing the dice.
For example:

- p(number 6 is rolled) = ?
- p(number of points > 4) = ?
- p(prime number) = ?

So how can you see if the dice is fair or not? You could do the same task with a different dice with, say, some numbers up twice, do the task again and see what happens.

e x t	**Materials** Smartphones or tablets, Documents (Information about biassed dice, Web address for students to research), GeoGebra software, Computers with internet access.
	Research to Prepare Lesson ● Read and discuss article(s) about gambling ● Consider them for **Economics** point of view (causing social issues) and/or **Psychology** point of view (what happen psychologically) , comparing different gambling habits around the world- Australia and the UK in the example below, and human behaviours ● Video provides a good link to misleading statistics use ● Articles:https://www.washingtonpost.com/world/2022/04/26/australia-gambling-addiction/ ● https://www.theguardian.com/society/2022/mar/23/gambling-addiction-could-be-nine-times-higher-than-industry-claims ● Also, a video about what happens in the brain of a gambling addict: https://www.youtube.com/watch?v=BF5SzIN63w8
	Resources ● https://www.washingtonpost.com/world/2022/04/26/australia-gambling-addiction/ ● https://www.theguardian.com/society/2022/mar/23/gambling-addiction-could-be-nine-times-higher-than-industry-claims ● https://www.youtube.com/watch?v=BF5SzIN63w8 ● https://www.tinkercad.com/
S T E M A c t i v i t y	**Ask** Discussion about the above issues, sharing thoughts and experiences in small groups before open group discussion. Outline key takeaways, what gambling is, dangers of gambling, places where gambling can take place, positive impact (?) of gambling - this is to encourage critical thinking and considering different perspectives, different forms of gambling (hopefully dice will come up from casinos). Some questions: ● What is a fair dice? Why do we call it fair? ● What does it mean that a dice is not fair? Do unfair dice exist? Why/why not? ● How could a dice be made unfair? (So many ideas could be generated here) - pair, small group discussion before class discussion takes place - **collect ideas**
	Research Have 2 dice in class - one biassed and one unbiased From the outside they look the same (may be colour coded for easy referencing later) ● Students have to play with both dice, note down the outcome of each throw and figure out: ○ Which one is biassed ○ Which one is unbiased ○ Give reasoning to their findings (for example how they know which one is which, use evidence to support their answer) ● With the biassed dice, students then have to figure out by playing and noting down the outcome of each throw: ○ How the dice is biassed (for example towards which number(s) ○ Guess about the way the bias was designed (they can refer to the previously collected ideas from the lead in activity)

Imagine

Link the activity back to the article/video by asking the students the following questions to open up discussion:

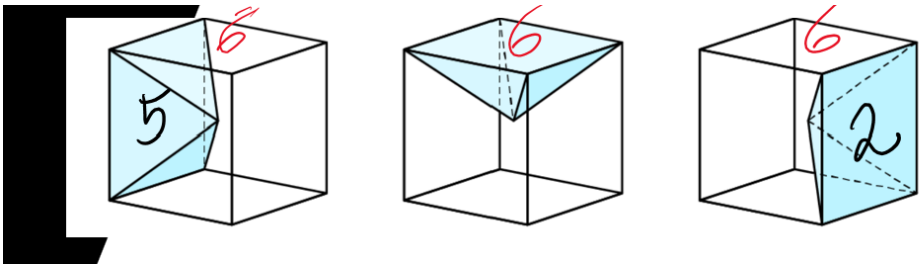
- How do you think this activity may be relevant to what has been discussed in the article/video? - this could be directed to the realities of winning in such games.
- How do you think slot machines are designed? Who will win? How do you know?
- Do you think casinos cheat? Why/why not? (do they have to?)
- Some further reading on how to recognise gambling addiction and where to turn to with such problems: https://www.psychguides.com/behavioral-disorders/gambling-addiction/how-to-help/

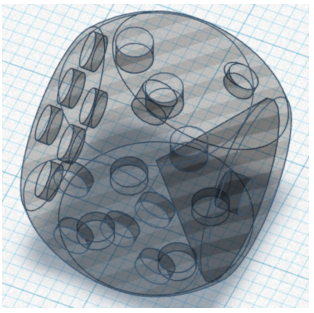
Plan

Depending on the class, this may take 90 minutes to do. Extension another 45 or 90 minutes (in groups though). It would take a lot of time, if each of the students printed out their own dice.

From the inside, one of the dice is printed so that (for example)

- One side is thicker
- One side is thinner
- Some weight is put in one corner (some bias towards some numbers), for example a pyramide, see pictures
- In addition, students have more fun when they are allowed to experiment themselves
- As a teacher, you have the freedom to create the cubes the way you want them to be, fair or not, with individual numbering and side faces thanks to the objects you create yourself.





Create

Students are asked to choose from the above collected ideas (from lead in) to make a dice biassed and design it using GeoGebra. They can also use Tinkercad to create their own printed 3D model so they can test it and compare with other groups and they could figure out the bias each group used in their dice, etc.

Test

Which die is the most likely to roll a 6?

Find out which one of you has the "best" 6 dice.

You should proceed as follows:

1. Everyone rolls their dice, which should be in a dice cup.
2. The result of each throw will be entered in the log table below under the appropriate throw number.
3. Whoever gets to 60 throws first shouts “stop”. Everyone else then stops rolling the dice immediately.

4. The (so-called absolute) frequencies for the individual numbers are to be noted in the tables below the protocol table.
5. When you are done with everything, first compare your results with those of your neighbours. Are there differences between the individual cubes? Explain why or why not!
6. What might be meant by the term relative frequency?

Number of throws: 60

Dice value	1	2	3	4	5	6
Absolut frequency						
Relative frequency						

Improve
Students' final reports should include explanations about how to create a biassed dice.

Materials

Smartphones or tablets, Documents (Information about biassed dice, Web address for students to research), GeoGebra software, Computers with internet access.

Test

This part will be completed by the teacher after the lesson plan is implemented in the classroom.

Improve

Each group could create a game using their own biassed dice.